A High-frequency Measure of Chinese Monetary Policy Shocks

Jianyao He, Dun Jia, Kai Li, and Wenbin Wu *

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Abstract

Measuring monetary policy surprises in emerging markets is challenging due to the complex institutional structures and ever-evolving policy regimes. We propose a two-step estimation procedure and apply it to the context of China, adaptable to frequent policy changes in emerging markets. Our approach isolates the common component of interest rate variations driven by monetary policy changes, thereby providing a high-frequency measure of Chinese monetary policy shocks. We identify significant causal impacts of monetary policy surprises in China on daily asset prices, including inter-bank interest rates, treasury rates, corporate bond yields, and equity prices, leading to substantial effects on macroeconomic aggregates.

JEL codes: E52, G12, G14

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*He: Naveen Jindal School of Management, the University of Texas at Dallas, Email: jianyao.he@utdallas.edu; **Jia**: HSBC Business School, Peking University, Email: dun.jia@phbs.pku.edu.cn; **Li**: HSBC Business School, Peking University, Email: kaili825@gmail.com; **Wu**: Fanhai International School of Finance, Fudan University, Email: wenbinwu@fudan.edu.cn. We thank comments and suggestions at various conferences and seminars. All errors are ours.

1. Introduction

It is crucial to have monetary policy shocks well measured before identifying the potential non-neutrality of monetary policy for causal inference (Christiano, Eichenbaum, and Evans, 1999). This is a challenging prerequisite when studying monetary policy impacts in emerging markets, given that the transmission mechanisms of monetary policy in these economies highly depend on their institutional structures[1], and their monetary policy regimes can be complex and constantly evolving (Unsal, Papageorgiou, and Garbers, 2022).[2] An integrated approach of monetary policy regime with multiple objectives and many different policy tools has been increasingly popular among emerging markets, which may provide themselves the well-tailored macroeconomic and financial stability (Gopinath, 2019; Basu, Boz, Gopinath, Roch, and Unsal, 2020).[3]

Previous literature on identifying the monetary policy shocks relies on the estimations of an interest rate determination rule or of a Vector Autoregressive (VAR) equation system (Taylor, 1993; Christiano, Eichenbaum, and Evans, 1999; Uhlig, 2005). More recently, the research agenda has been focused on the higher frequency dynamics of financial data in very short windows of the announcement events of key monetary policy instruments (e.g.,

[1]Fast build-up of leverages in African countries have been found to impede the monetary policy transmission, which posed practical challenges to many African central banks (Christensen and Schanz, 2018). The effects of Chinese monetary policy appeared to be mixed with those of shadow banking financing and fiscal policy in China (Chen, Ren, and Zha, 2018; Chen, Gao, Higgins, Waggoner, and Zha, 2023).

[2]Borio (2019) systemically summarizes the fact that emerging markets are moving away from the standard inflation-targeting monetary policy regimes commonly adopted in the advanced economies. For example, with de jure exchange rate flexibility, central banks in emerging markets are often seen to place the exchange rate stability as the de facto primary anchor over any inflation objective (IMF, 2015). In addition, central banks in Indonesia and China among many others also changed their policy targets from the quantity-based, e.g., a broad money measure such as the M2 growth, to the price-based instruments, e.g., policy-anchored short-term interest rates.

[3]For example, the central bank of China, the People's Bank of China (PBOC), carries on quite a few policy objectives beyond the simple inflation-targeting, including to maintain the currency and price stability, to promote the economic growth and employment, and to ensure the financial stability. Since 2013, POBC is also dedicated to assisting in the advancement of the financial reform and opening up in China and to further promote the development of domestic financial markets (Yi, 2023). Regarding a wider use of available policy tools other than policy interest rate adjustments, central banks in emerging markets frequently use lending facilities by which the central bank directly injects liquidity into the banking system. To name a few, these economies include India, Indonesia, Malaysia, Thailand, Brazil, Chile, China, Colombia, Mexico, Peru, Israel, Russia, Saudi Arabia, and South Africa(Van't Dack, 1999; Warjiyo and Juhro, 2019).

See Kuttner (2001), Nakamura and Steinsson (2018), and Swanson (2021) for the Federal Reserve's FOMC announcements of the Federal Funds Rate targets in the U.S. market and Altavilla, Brugnolini, Gürkaynak, Motto, and Ragusa (2019) for the ECB's announcements of Key ECB interest rates in the euro area.).[4] However, a parsimonious way of measuring the high-frequency monetary policy shocks in emerging markets, conditional on their more complex monetary policy regime, is long missing. Particularly, while the emerging markets are increasingly capitalized (David, Henriksen, and Simonovska, 2016; Amstad, Sun, and Xiong, 2020), little is known about the asset pricing implications of their domestic monetary policy risk if the policy shocks are derived from the non-financial data of lower frequency.

Our paper fills this gap in the literature by introducing an easy-to-implement approach and first applying it to the market setting of China. Our methodology therefore enables us to construct a high-frequency interest rate-based measure of monetary policy shocks in China, despite its complex and multi-dimensional monetary policy regime. It is potentially adaptable to frequent policy changes in emerging markets. In the spirit of Fama and MacBeth (1973) and Bu, Rogers, and Wu (2021), our approach is a heteroscedasticity-based partial least squares (PLS) method, which involves two steps for shock identifications.

First, we exploit the interest rate dynamics in short windows of a wide coverage of the different types of announcement events of the central bank of China, the People's Bank of China (PBOC). These events are most relevant to monetary policy changes in China in different dimensions. In specific, we consider PBOC's policy changes regarding open market operations in the form of reverse repurchase agreements, liquidity injections to the banking system via lending facilities, changes in the reserve requirement ratio along with changes in the benchmark deposit rate and loan prime rates. Given multiple policy instruments used by the PBOC, we run time-series regressions to estimate the average sensitivity of our selected response interest rates of different maturities across policy events and tools, which measures

[4] A separate and very recent research agenda applies textual analysis on the documents of the central bank policy statements to extract the unexpected shock component of the monetary policy decision. See Drechsel and Aruoba (2022), Handlan (2022), and Doh, Song, and Yang (2022).

the response rates' risk exposure to monetary policy, i.e., the betas.

In the second step, we then run repeated cross-sectional regressions of the response interest rates on the betas to back out the common and unobservable component of the interest rate variations in response to averaged monetary policy changes across day events. Ultimately, we obtain a single time series of Chinese monetary policy shocks of daily frequency out of all the institutional complexities.

Regarding the selection of the response rates in our application, we examine the market responses of the issuance interest rates of the Negotiable Certificate Deposits (NCD) across different maturities of daily frequency. Our choice of the response rates is motivated by the fact that the inter-bank market is the primary target market for the ongoing practice of Chinese monetary policy (Yi, 2018, 2023). Importantly, the NCD market has quickly developed into one of the most important inter-bank markets. Therefore, we take the NCD interest rate dynamics to proxy for the cost changes of inter-bank borrowing upon monetary policy changes. In particular, the NCDs are issued by a predominant share of the deposit-taking banks in China. The issuing banks obtain the non-deposit source of borrowing at a cost in a market setting. By 2022, 2051 banks have been actively issuing the NCDs and trading the assets among each other, and the outstanding NCD balance has reached about 15 trillion yuan. Hence, by construction, the NCD issuance rates are tightly related to the balance sheet management of banks, which are reflective of the real-time costs of inter-bank borrowing.

Our approach of constructing the monetary policy shocks has two important merits. First, our approach accommodates the institutional details and the evolving complexity of monetary policy practice in China. In specific, the PBOC has continuously pushed forward efforts to introduce newer tools in addition to the traditional toolkit. Since 2013, the PBOC has been regularly doing transactions with banks in the inter-bank market through repurchase agreement transactions (repo) and liquidity injections via short-term lending facilities (SLF) to target the 7-day repurchase rate pledged for interest rate bonds by deposit-taking institutions in China's inter-bank market (DR007). In addition, the PBOC regularly manages the longer-term liquidity operation with the banks via medium-term lending facilities (MLF) in order to target the longer-term interest rate, i.e. the Loan Prime Rate (LPR) associated with bank lending. By ransacking a long list of the PBOC's monetary policy events affecting the costs of borrowing in the inter-bank market and considering the rate responses of the entire term structure of the NCD rates, our estimation procedure isolates the shocks driven by *averaged* changes across Chinese monetary policy tools that carry on both the shorter-run and longer-run impacts. Our methodology therefore effectively achieves the benefit of dimension reduction which not only opens for further inclusion of newer policy tools in the future, but also allows for narrowing the focus on a specific policy instrument in retrospection. Most importantly, the event-based identifications as featured by our approach well adapt to settings of other emerging markets which similarly see frequent monetary policy changes using multiple policy tools.

Second, using the daily NCD data covering a larger number of issuing banks in China, we are enabled to continuously update our shock series over time. According to the regulation on the information releases of the NCDs, the National Inter-bank Funding Center (NIFC) under the supervision of the PBOC timely publishes the contract details of each NCD issuance associated with each bank issuer.[5] Therefore, the real-time data availability of NCD interest rates is guaranteed as long as the NCD market in China is well regulated and continuously developed. Hence, as the important data product of this paper, our constructed shock series will be timely updated, which best serves the international research community.

Our interest rate-based monetary policy shock times series are constructed based on data covering the years from 2015 to 2021. Positive (negative) shocks are realigned to indicate unexpected interest rate increases (decreases) driven by exogenous monetary tightening (expansion) in China. We find that our measured monetary policy shock dynamics are well consistent with the known monetary policy cycles in China. For example, our results sug-

[5]See the regulation details in "Rules for the Issuance and Trading of Inter-Bank Certificates of Deposit in the Inter-Bank Market"(Yinhang Jian Shichang Tongye Cundan Faxing Jiaoyi Guicheng)

gest that there were substantial interest rate cuts in 2015 after the Chinese stock market underwent dramatic booms and busts. The monetary tightening in 2017 aiming to counter-strike the rising systemic risk with the significant efforts of deleveraging are well captured by the interest rate hikes in our measured shocks. We also see the significant monetary expansion at the onset of the COVID-19 pandemic in early 2020 picked up by our measured interest rate cuts.

Given our identified shock series, we then examine how asset prices are affected by monetary policy surprises in China. Based on the time-series regressions conditional on monetary policy announcement days, we first show that monetary tightening results in immediate increases of the market rates in the NCD market across all available maturities, which confirms that our PLS methodology is able to extract the common interest rate variation due to monetary policy shifts. Further, we show that the monetary policy-induced interest rate hikes in China consistently raise a range of other interest rates and prices of interest rate swaps operating in the inter-bank market. This lends additional credence to the very basics of our methodology that Chinese monetary policy practice is indeed operating via the inter-bank markets. Importantly, we provide additional evidence suggesting that increases in the policy-triggered interest rate shocks can significantly shift up the treasury yields, the corporate bond yields, and the enterprise bond yields. These results substantiate our findings that with our shock measure, monetary policy tightening in China is indeed contractionary in terms of asset pricing.

We further apply the local projection method as in Jordà (2005) to pin down the dynamic effects of Chinese monetary policy on asset prices. We find that the policy-induced interest rate hikes are raising interest rates with varied persistence across different rates. Specifically, the immediate price drops of the interest rate swaps last for two trading days whereas the corporate bond yield jumps carry on for twelve trading days. With muted effects on impact, we see significant drops in stock prices starting about 2 weeks after the policy tightening. In addition, based on our estimations of a VAR system with our shock series included, we document that the contractionary monetary policy leads to significant drops in production, decreases in consumer prices, and increases in the credit spread. Our empirical evidence suggests that the interest rate-based monetary policy shocks consistently shift the asset prices and the real macroeconomic aggregates in China, which are well consistent with general theoretical predictions. Importantly, our paper documents that monetary policy transmissions in China are little affected by the potential confounding "information effect" as it may contaminate the effectiveness of the U.S. monetary policy (Nakamura and Steinsson, 2018; Bauer and Swanson, 2023).[6]

The paper is structured as follows. In Section 2, we describe the essential institutional backgrounds of the monetary policy practice in China and provide the details of the monetary policy events we consider in our paper. Section 3 elaborates the details of our empirical setting including the discussion of various data sources and a comprehensive description of the NCD data. In Section 4, we discuss our methodology employed to construct the high-frequency shocks and examine the properties of our measured shock series. Section 5 presents the estimates of the immediate and dynamic effects of our measured monetary policy surprises on asset prices and examines the transmission of Chinese monetary policy into the real economy. Section 6 concludes.

Related Literature. Our paper is related to three strands of literature. First, a rich line of work has been devoted to identifying the unexpected shocks to the overnight inter-bank borrowing rate as targeted by the U.S. monetary policy. Earlier papers isolate the orthogonalized innovations to the U.S. Federal Funds Rate by estimating the VAR system with some assumptions on the shock structure, either using recursive ordering or sign restrictions

[6]Central bank's announcements of monetary policy decisions may be delivering additional information effects which mix the direct effects of monetary policy changes. For example, if a central bank surprises the market by tightening the policy interest rate, the stock market prices may increase given that the market interprets this action as a positive signal that the economy is doing quite well (see also Romer and Romer, 2000; Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford, 2012; Miranda-Agrippino, 2016; Hansen, McMahon, and Tong, 2019; Cieslak and Schrimpf, 2019; Paul, 2019; Jarociński and Karadi, 2020; Lunsford, 2020).

(Christiano, Eichenbaum, and Evans, 1999; Uhlig, 2005). In addition, a narrative approach with augmentation of applying the textual analysis or some combination of machine learning techniques is also adopted to back out the "correct" interest rate shocks once the estimations are conditional on some measure of the central bank's internal information (see Romer and Romer, 2004; Drechsel and Aruoba, 2022; Handlan, 2022). Another approach is to take the high-frequency bond market data for identifications of the interest rate shocks on the U.S. FOMC announcement days (see Kuttner, 2001). In much of this more recent literature, the surprise component of the monetary policy is measured by the changes in the interest rate futures prices in very narrow windows centering the FOMC announcements (see for example Nakamura and Steinsson, 2018; Rogers, Scotti, and Wright, 2018). Importantly, the U.S. monetary policy can be further spanned by extra risk factors including the Forward Guidance and the Quantitative Easing in the U.S. (Gürkaynak, Sack, and Swanson, 2005; Gertler and Karadi, 2015; Swanson, 2021). In this paper, our methodology of constructing the Chinese monetary policy shocks accommodates the fact that the inter-bank cost of borrowing among Chinese banks can be well affected by PBOC's multiple policy tools across many event windows. In line with this literature, we examine the interest rate dynamics of daily frequency in short windows of important monetary policy events of the largest emerging market economy, China. To achieve the benefits of dimension reduction, we follow Bu, Rogers, and Wu (2021) and develop the heteroscedasticity-based partial least squares (PLS) approach to identifying shocks to Chinese monetary policy as captured by the common interest rate variations of different maturities driven by various monetary policy events. Our paper is thus the first paper that provides the high-frequency measure of monetary policy shocks in an emerging market economy which results in a tractable and single time series. Importantly, based on the identifications (Gürkaynak, Sack, and Swanson, 2005; Swanson, 2021), we confirm the parsimony of our approach and measurement that Chinese monetary policy shocks can be sufficiently summarized by one single interest rate level factor only.

Second, our paper is related to the work that explores the impacts of the central bank announcements on financial markets. Savor and Wilson (2013, 2014) find that the U.S. equity market exhibits larger excess returns on FOMC announcement days relative to non-announcement days. Lucca and Moench (2015) document the pre-announcement premium in response to the FOMC announcements. Ai and Bansal (2018) and Ai, Bansal, and Han (2021) theoretically show that the pre-announcement premium can be a result of investors with recursive preferences acquiring information in response to incoming central bank announcements. Hu, Pan, Wang, and Zhu (2022) uncover that the heightening and the subsequent reduction of market uncertainty are relevant for generating the pre-FOMC announcement premium. Brusa, Savor, and Wilson (2019) show that the equity markets of many countries all exhibit strong reactions to the U.S. FOMC announcements. Fleming and Remolona (1999) and Balduzzi and Moneta (2017) explore the FOMC announcement effects on the treasury and bond market, respectively. Muller, Tahbaz-Salehi, and Vedolin (2017) examine the pricing impacts of the FOMC announcements on the exchange rate markets. Guo, Jia, and Sun (2023) document that Chinese stock markets accumulate positive returns before the PBOC's data releases of China's monetary aggregates statistics. While the existing studies are mostly based on direct comparisons of asset market performances in and outside the announcement windows, our paper, however, identifies the causality by seriously disentangling the high-frequency monetary policy shocks in China. Our paper therefore gives a comprehensive overview of the impacts of monetary policy on different asset classes in China including the inter-bank interest rates, treasury and corporate bond yields, and stock prices.

Third, our paper is closely related to the literature that delves into the effects of changes in regulation and policies on the Chinese economy. Cong, Gao, Ponticelli, and Yang (2019) and Huang, Pagano, and Panizza (2020) both show that the state-owned enterprises (SOE) benefited the most by increasing their borrowing and investment in mid of the massive monetary and fiscal expansion during the years of 2008-2010, when China introduced increases in the nation-wide budgetary spending by about four trillion RMB. While the former paper emphasizes the governments' favoritism of SOEs by providing additional implicit guarantees on the SOE borrowing, the latter focuses on the direct crowding out of private debts. Ru (2018) finds that the Chinese government's fiscal advancement via the credit expansion of China Development Bank (CDB), the major policy bank in China, favors the SOE firms and crowds out the private investment in those dominant sectors. Chen, Ren, and Zha (2018) and Chen, He, and Liu (2020) provide substantial evidence showing that fiscal and monetary expansion in China triggered the rise of shadow-banking business in China that took on excessive credit risk. Chen, Gao, Higgins, Waggoner, and Zha (2023) find that the fiscal expansion through increased government-backed infrastructure investment has weakened the monetary policy transmission to private firms in China. While the existing papers do not intend to separate the mixed effects of fiscal and monetary policy and mostly focus on the macro implications of an important credit expansion window of 2008-2010, it's less clear if they can cleanly isolate the average transmission mechanism of Chinese monetary policy only. Our paper, by identifying the interest rate shocks driven by monetary policy events in China, works around the existing problem that increases in the total quantity of outstanding credit in China are a result of both fiscal and monetary stimulus. Our paper therefore provides a cleaner estimation of monetary policy transmission in China.

Two papers closest to ours are Chen, Ren, and Zha (2018) and Das and Song (2023). Chen, Ren, and Zha (2018) is one of the few pioneer studies working on a solution to measure Chinese monetary policy shocks concerning the institutional uniqueness of the Chinese economy. In the spirit of Taylor (1993), they develop a measure of China's monetary policy shocks based on the innovations to China's M2 growth rates, conditional on whether the GDP growth and the inflation rate fall short of some targets. Our paper therefore complements in a way that we are measuring the interest rate-based monetary policy shocks in consideration of the fact that China's monetary policy is transitioning from the quantity-based (M2) to the price-based (interest rates). On the other hand, Das and Song (2023) directly measure Chinese monetary policy shocks using high-frequency changes of the 1-year

R007 interest rate swap (IRS) prices in windows of the PBOC's monetary policy events.[7] Our paper differs in three-fold. First, we build our approach based on the institutional reality that the Chinese monetary policy operations are mainly working through the effects on the markets of inter-bank borrowing. Second, we consider a wider range of monetary policy announcement events and the entire term structure of the NCD rates to extract the common interest rate variations across maturities as the averaged monetary policy shocks. Third, our results suggest that interest rate-based monetary policy shocks in China have distinctive effects on asset prices and the macroeconomic aggregates, whereas Das and Song (2023) note that their measured shocks have to be coupled with the fiscal policy surprises to initiate significant transmissions.

2. Institutional Details: Monetary Policy in China

2.1. Monetary Policy Practice in China

We briefly review the history of Chinese monetary policy in this section. We see that China's central bank, the People's Bank of China (PBOC), is a constantly learning central bank that has been taking initiatives to update and improve its monetary policy framework over time. An important feature of this policy framework is that the monetary policy transmission into the real economy in China heavily relies on the well-functioning of China's inter-bank market, which requires the participating banks and non-bank financial institutions to respond to monetary policy changes through their balance sheet management (Yi, 2018, 2023). Responsiveness of the very important banking sector eventually translates into changes in the asset pricing in the market and the credit allocation to businesses. Therefore, catering to the evolving needs of economic development and financial market stability,

[7] R007 interest rate and DR007 are both inter-bank interest rates in China. R007 refers to the 7-day weighted average interest rate of repurchase agreements, while DR007 refers to the 7-day weighted average interest rate of pledged repo transactions. One key difference between the two is regarding the type of participating institutions. The market determining R007 covers non-financial institutions (R007) whereas that of the DR007 include mostly commercial banks with higher quality securities as pledge.

Chinese monetary policy has been developed to have an increasingly richer set of policy tools.

The PBOC first assumed its role as China's central bank in 1984. From 1984 to 1997, the PBOC strictly regulated quotas on credit and cash supplies to contain domestic inflation and to promote economic growth. In 1996, the quantity-based measure of aggregate money supply, for example, growth in the broad measure of monetary aggregates M2, was officially set as an intermediate target for China's monetary policy practice. In 1998, China abolished the PBOC's credit quotas set for major national banks. The PBOC has since started working with standard monetary policy tools including the Open Market Operations (OMO), managements on the Required Reserves Ratio (RRR), adjustments on the benchmark loan interest rates (BLR), and others to indirectly achieve money growth targets.

Since 2013, shrinkage in the foreign reserves and fluctuations in financial markets in China pushed the PBOC to initiate innovative but nonstandard monetary policy tools. These policy initiatives helped reestablish the stability of China's money market and credit market, and effectively shifted the credit allocation mode in China towards a need-based system that caters to business demands through the banking sector. In specific, the PBOC has been regularly carrying out both the short-term lending facilities (SLF) and the medium-term lending facilities (MLF), under which the PBOC makes discount loans directly to the banks in need of extra central bank liquidity. That is, the PBOC conducts SLF operations to fulfill the temporary demand of banks whereas the MLF operations aim to expand the longer-term liability of banks in China. These lending facilities eventually trigger changes in banks' asset purchases, credit allocations, and liability adjustments through their impacts on the cost of inter-bank borrowing. In particular, the PBOC has implemented active interest rate corridor management to guide the formation of inter-bank interest rates. That is, given that the interest rate related to the SLF operations and the interest rate paid on the excess reserves as upper and lower bounds of the rate corridor, the PBOC regularly applies the 7-day reverse repo (RevRepo) transactions to target the key inter-bank rates including the

DR007 and R007. Rates on the longer-term MLF operations then help determine the Loan Prime Rate (LPR) as the key reference bank loan rate.

On some other occasions, the PBOC implemented some policy tools in some years but phased out the practice in later years. For example, before using the MLF operations to target at the LPR, the PBOC used to take more rigid management on the BLR. Since 2019, it has been required that all new bank loans in China be priced relative to the LPR, which effectively replaced the central role of the BLR. Also, the PBOC introduced the Pledged Supplementary Lending (PSL) program in 2014, which directed the central bank liquidity to the national policy and development banks for financing national projects. However, this policy tool was not used for a few years until relaunched in the end of 2022.

2.2. Selection of the Monetary Policy Events

Our paper examines the responses of the inter-bank NCD rates to Chinese monetary policy changes in short event windows and then uncovers the monetary policy shocks in China. In reviewing the advancements of monetary policy in China, we further discuss our selection of the monetary policy events for shock identifications. We consider the PBOC's monetary policy events if they satisfy the following criteria. First, since the inter-bank interest rates in China can be affected by multiple policy tools, a diverse set of policy tools should be examined. Second, to identify the short-window interest rate responses to policy changes, our considered monetary policy events should be identifiable by the dates and times of PBOC's monetary policy announcements that release the policy decisions related to the real-time market conditions. This also requires that we should exclude those PBOC's announcements that publish market statistics in a delayed fashion. Third, considering the fact that newer policy tools may be replacing the previous policy instruments, the replacements or upgrades of tools that could have similar market impacts should be considered jointly in our study. Fourth, even if we are isolating the interest rate responses, we also consider the rate impacts of those quantity-based monetary policy adjustments. This is to respect the fact that market interest rates can be indirectly affected by these operations.

Finally, we have identified 146 monetary policy events that meet our criteria over the sample period from January 2015 to December 2021. Specifically, our sample consists of various traditional operations, including PBOC's announced changes to the RRR and open market operations through RevRepo that influence the 7-day RevRepo interest rates. We also consider policy events that announced changes to the BLR and LPR with the latter replacing the role of the former in recent years. In addition, we consider all events of MLF operations covered in our sample, which are announced in mid of each month. These MLF operation events are selected regardless of whether the MLF rate associated with the MLF operation is changed because the NCD rates can be affected by the quantity changes of the MLF operations over monthly cycles.[8] For further details, we relegate Section B of the Internet Appendix to discuss the exact definitions, the scopes and the associated announcement events of these aforementioned monetary policy practices.

3. Data and Descriptive Statistics

The data employed in this paper is drawn from a diverse array of sources. We obtain the precise timestamps for each of our considered monetary policy announcement events directly from the PBOC's official website.[9] Daily financial data including the inter-bank market interest rates, bond yields, and the stock market price indexes are sourced from the Choice Database. The issuance interest rates on NCDs are obtained from Wind, which collects the original data published by the NIFC in daily frequency. For monthly economic activity indicators, we take the Industrial Value-added among enterprises of designated sizes (IVA)

[8]For example, the interest rates and the quantities of SLF operations conducted in a month won't be announced until the first week of the following month. The monthly monetary aggregates numbers including the M2 along with the amount of the social total financing are also published in the next month in a delayed fashion. We therefore do not consider these types of events for identifying the real-time response of inter-bank market interest rates.

[9]We note that a very small set of PBOC's announcements in the early years of our sample were initially disseminated through PBOC's official account on Sina Weibo, a Chinese social media platform equivalent to Twitter. These Weibo posting timestamps were therefore used instead.

and the Producer Price Index (PPI) data from Wind. Next, we discuss the identification of a monetary policy event window based on the announcement timing. Then we provide a detailed discussion of the NCD issuance in China's inter-bank market.

3.1. Event Window

As illustrated in Table 1, the release time of a monetary policy announcement may be at any point within a trading day during trading hours, outside trading hours, or even on weekends. To ensure that a 1-day event window after the monetary policy announcements captures the reactions of the NCD interest rates, we defined the monetary policy announcement day as follows. If a monetary policy announcement arrives before 5:00 p.m. on a trading day t, day t is the announcement day. However, if a monetary policy announcement arrives at the market after 5:00 p.m. on a trading day, on weekends, or over the holidays, the announcement day is associated with the first following trading day. The day cutoff timestamp 5:00 p.m. is chosen as it marks the market close of the trading hours of the money, bond, and inter-bank markets affiliated with the China Foreign Exchange Trade System (CFETS) and the NIFC, which operates from 9:00 a.m. to 12:00 p.m. and 1:30 p.m. to 5:00 p.m. on a regular trading day. We confirm that our empirical results are robust if the threshold is arbitrarily set at 4:50 p.m. or 3:00p.m.[10] We then finalize with 138 distinct monetary announcement days out of the 146 selected monetary policy events according to the event window definition. Additional information on the co-released announcement days can be found in the Internet Appendix B Table IA.4.

3.2. NCD Data

The NCD dataset records the comprehensive details of every book-entry NCD issued by deposit-taking financial institutions, mostly commercial banks, in China's inter-bank

[10] Stock markets on the Shenzhen Stock Exchange and Shanghai Stock Exchange close trading at 3:00 p.m. on a regular trading day.

market. This dataset is obtained from Wind and originates from NIFC, an entity that offers services related to issuance, trading, and information concerning inter-bank NCDs. Under the authorization of the PBOC, the NIFC releases the NCD market information in real-time up to daily frequency. Each data entry of this dataset captures a newly issued NCD and encompasses the following details:

i) NCD Issuance-related: abbreviated NCD name, yield of return (referred to hereafter as NCD rate), trading code, trading status, announcement date, actual NCD issue date, planned issuance amount, actual issuance amount, maturity, price, coupon payment type, accrual date, due date, issuing method

ii) Issuer-related: Issuer's name, registration province, credit rating, issuer type.

Importantly, in accordance with the stipulations set forth by the NIFC, we note that each announcement concerning an NCD issuance is to be publicly disclosed to all investors at least one trading day prior to the actual NCD issuance day and the reference yield of return has been pre-specified one day before its actual issuance. We therefore align the announcement dates of all the NCD issuance in our sample, rather than dates of the actual issuance on the trading day after the announcement, with our pre-defined monetary policy announcement days. Then we look into changes in the inter-bank cost of borrowing as proxied by the yields of return on NCDs driven by monetary policy changes on the monetary policy announcement days and over the subsequent days.

3.3. Descriptive Statistics

We summarize the key statistics of our data in this section. Over our sample years, nearly all issued NCDs are of 5 maturities of one month, three months, six months, nine months, and one year. Only 0.07% of NCDs have a maturity of two years, while an equally small 0.09% have a maturity of three years. Figure 1 illustrates the aggregate value of NCDs issued in each year across these 5 main maturities. The plots show that starting from 5 trillion RMB yuan in 2015, the market cap surged to 13 trillion yuan in 2016 with this trajectory sustained in the ensuing period. This rapid escalation during the period from 2015 to 2017 is well in line with the PBOC's general strategy to channel the central bank liquidity through the banking sector. Given the high trading volume of NCDs in the secondary market, NCDs organically emerged as a cornerstone financial instrument of the inter-bank market in China. Moreover, during the first half of our sample period, the 3-month contract claimed dominance, while in the latter half, the 1-year contract superseded it.

Table 2 presents the average amount per NCD issuance across various issuer types and the five main maturities, along with the count of issued NCDs and the number of participants within each issuer category. Among these issuer types, urban commercial banks stand out as the most prolific issuers, contributing the largest share of NCD issuance. In contrast, rural commercial banks dominate the category of issuer participation, displaying as the most active issuers in terms of shares of issuer types. Notably, urban commercial banks issue twice as many NCDs as rural commercial banks, despite rural banks significantly outnumbers the universe of urban ones. In addition, the per-issuance amount by urban banks is about 532 million yuan, slightly larger than that of 339 million yuan of rural banks.

Joint-stock commercial banks and state-owned commercial banks, both serving as primary dealers authorized by the PBOC to engage in the market of government securities, monetary policy instruments and other financial products issued by the PBOC, exhibit a higher amount per issue, at 1.64 billion and 2.84 billion yuan, respectively. This distinction is rational, given their strategic role in transmitting liquidity from monetary instruments, such as reverse repurchase, SLF, and MLF, to other financial institutions through the NCD market. Consequently, despite issuing fewer NCDs than urban and rural commercial banks, they tend to allocate larger amounts per issuance. Other banks, such as foreign-invested and private banks, play a minor role in the NCD market.

Considering both the scale and quantities of issuance, we then focus on the following dominant NCD issuer types: urban commercial banks (UCB), rural commercial banks (RCB), joint-stock commercial banks (JSCB), and state-owned commercial banks (SOCB). Considering the heterogeneities both at the NCD and the bank level, we aggregate the issuance level NCD rates for further analysis. Specifically, we take the NCD rates as weighted by the actual issuance amounts across the four primary issuer types and the five main maturities for each day. This effectively yields a panel of 20 NCD interest rate series of daily frequency, with their pairwise daily correlations around 0.90 and being statistically significant at 1% level. In case some issuer types do not have data points covering all five maturities on a day, we take the first available issuance amount-weighted NCD rate observed on the previous day.

By aligning the 20 portfolio-based daily NCD interest rates with our announcement day windows, we first validate the presumption that monetary policy changes indeed trigger sizable impacts on the NCD market, for example, by influencing NCD issuance rates. The findings are summarized in Table 3, which report the mean and standard deviation of absolute changes observed in the 20 NCD portfolio rates. Specifically, the analysis compares days featuring the impacts of monetary policy announcement events with those on non-announcement days. Over half of the rates exhibit larger and more volatile absolute changes on days with monetary policy announcements compared to days without the policy impacts. The average absolute changes across all 20 rates on days marked by policy events amount to 6.19 basis points, exceeding those observed on non-event days by 0.3 basis points. Our findings based on the NCD markets strongly then double confirm the institutional fact in China that Chinese monetary policy is executed to predominately operate via the banking channel.

4. Methodology and Construction of Shocks

We introduce the methodology to construct our high-frequency measure of China's monetary policy shock in this section, with our baseline measured shock series estimated in the spirit of the two-step Fama-MacBeth procedure using the Partial Least Square (PLS) approach (Fama and MacBeth, 1973; Bu et al., 2021). As a robustness check, we also present a shock series derived from the first component of the principal component analysis (Gürkaynak et al., 2005; Swanson, 2021) to cross-verify our results. In Section A of the Internet Appendix, based on the factor analysis, we show how we construct this alternative measure and why our constructed single series shocks are parsimonious and sufficient to capture the unexpected changes in Chinese monetary policy. In the following, we outline the details of our estimation process.

4.1. Baseline Measure: Partial Least Square Approach

Our methodology of shock construct builds upon the fact that the latent monetary policy shock e_t is unobserved yet induces variations in the NCD interest rates upon the officially announced monetary policy changes, as shown in Section 3.3. We first normalize the unobserved shock e_t to have a one-to-one relationship with the 1-year NCD issue rate of urban commercial banks, denoted as UCB(1Y), for the following reasons. First, urban commercial banks are the most active NCD issuers in terms of issuance volume across all five maturities. Second, unlike the joint-stock commercial banks and state-owned commercial banks, which all are primary dealers, urban commercial banks represent a mixture of primary and non-primary dealers. Therefore, their NCD issue rates encompass both the direct liquidity adjustments targeted by the PBOC and the subsequent dynamics of transmission of liquidity in the inter-bank market. Third, the 1-year maturity ranks as the most commonly issued NCD type by urban commercial banks.

In line with Bu et al. (2021), we then extract the monetary policy shocks e_t from the shared component of interest rates driven by policy changes, following the fact that the outcomes of monetary policies are reflected in the fluctuations of the NCD interest rates as market responses. In this context, we examine 20 NCD issuance rates as the array of outcome or response variables, comprising the actual issuance amount-weighted NCD rates across different issuer types (UCBs, RCBs, JSCBs, and SOCBs) and various maturities (1-

month, 3-month, 6-month, 9-month, and 1-year). Elaboration on the construction of these 20 NCD rates are detailed in Section 3.3.

Specifically, our method of shock construction involves two steps. In the first step, for each issuer type j or NCD issuance of maturity j, the sensitivity β_i^j of outcome variables to monetary policy is estimated from the time-series regressions of the outcome variables, changes in the NCD interest rates, $\Delta r_{i,t}^j$ on the unobserved monetary policy shock e_t within the defined 1-day announcement event window t, as expounded in Section 3.1. Specifically, we consider the specification,

$$\Delta r_{i,t}^j = \alpha_i^j + \beta_i^j e_t + \varepsilon_{i,t}^j \tag{1}$$

where $\Delta r_{i,t}^j = r_{i,t}^j - r_{i,t-1}^j$ captures the changes in NCD rates and $\varepsilon_{i,t}$ are factors unrelated to monetary policy announcements.

By adopting our normalization scheme, we can reconfigure Equation (1) as follows:

$$\Delta r_{i,t}^j = \theta_i^j + \beta_i^j \Delta r_{\text{1-year},t}^{\text{UCB}} + \xi_{i,t}^j \tag{2}$$

where $\xi_{i,t}^j = -\beta_i^j \varepsilon_{\text{1-year},t}^{\text{UCB}} + \varepsilon_{i,t}^j$. Here, β_i^j measures the sensitivity of each NCD issue rate to the monetary policy shock. It is worth noting that $\varepsilon_{\text{1-year},t}^{\text{UCB}}$ denotes the error term in the policy indicator. As observed in Equation (1), the regressor $\Delta r_{\text{1-year},t}^{\text{UCB}}$ showcases a correlation with the error term $\xi_{i,t}^j$, stemming from the $-\beta_i^j \varepsilon_{\text{1-year},t}^{\text{UCB}}$ component. In order to address this inherent error-in-variable challenge, we employ the heteroskedasticity-based estimator method proposed by Rigobon (2003) and Rigobon and Sack (2004), enabling the consistent estimation of β_i^j via instrumental variables (IV). This estimation methodology via IV follows that of Bu et al. (2021).

In the second step, we undertake the cross-sectional regressions of $\Delta r_{i,t}^j$ on the estimated sensitivity $\hat{\beta}_i^j$ for each day t to uncover the aligned monetary policy shocks e_t^{aligned} in a single time series of daily frequency.

$$\Delta r_{i,t}^j = \alpha_i^j + e_t^{\text{aligned}} \hat{\beta}_i^j + u_{i,t}^j, t = 1, 2, ..., T \tag{3}$$

where e_t^{aligned} is the coefficient of interest. The series of T estimated e_t^{aligned} values from the second step regressions, normalized to $\Delta r_{\text{1-year}}^{\text{UCB}}$, subsequently form our primary high-frequency measure of Chinese monetary policy shocks and henceforth denoted as our baseline PLS shocks.

4.2. The Shock Series

Panel (a) of Figure 2 plots our proposed high-frequency monetary policy shock series in units of percentage points, i.e., the PLS shocks, of daily frequency. Meanwhile, Panel (b) plots the monthly aggregated shock series. In these panels, positive (negative) shocks are derived to indicate unexpected interest rate hikes (cuts). We observe substantial interest rate cuts during the period of the 2015 Chinese stock market turbulence, as well as at the onset of the COVID-19 pandemic in early 2020. Over the years of 2017 throughout 2019, rounds of deleveraging efforts initialized by the PBOC were well picked by our interest rate jumps in these years. Additionally, we note some seasonality that rate cuts are more prevalent towards the end of each year. Importantly, our shock series appear to be very cyclical, with occurrences of positive and negative shocks displaying comparable likelihoods. This lends additional credence to our methodology given that by definition, the constructed shock series of surprise components shouldn't be carrying on too much persistence over time with path-dependent predictability.

Figure 3 provides additional comparisons between our baseline shock series and the changes in the underlying monetary policy instruments. Our identified policy shocks and the movements of interest rate instruments generally line up in terms of direction. Moreover, the magnitudes of the shocks tend to be relatively smaller compared to the raw rate changes.

This suggests that our constructed shock series indeed captures the unexpected component of interest rate changes, which are the residual variations other than the endogenous monetary policy reactions to the engorging economic development and the financial disturbances.

In addition, we examine the robustness of our baseline shock construction to sample selections of issuer types and interest rate types. Specifically, by excluding the five NCD issuance rate series associated with SOCBs and by considering the top three issuer types in terms of NCD issuance only, we find the differently constructed shock series exhibit a remarkably high correlation coefficient of 0.9854 with our baseline shock series.

5. Transmission of Monetary Policy Shocks in China

In this section, we analyze the immediate and dynamic effects of our constructed monetary policy shocks on key interest rates and asset market valuations in China. We assess both the short-term and dynamic impacts across a diverse set of asset classes, including the NCD rates and yields, other key interest rates in the inter-bank market, interest rate swaps, treasury yields, credit yields, and stock market indexes. First, in a regression setting, we show the effects of monetary policy shocks on impact. Then, in a local projection setup, we introduce a 1 percentage point rate increase driven by positive monetary policy shocks in order to identify the dynamic effects of having an unexpected monetary contraction. Lastly, we examine the monetary policy shock's transmission to the real economy via a structural vector autoregression (SVAR).

5.1. Effects On Impact

We first examine the effect of our high-frequency Chinese monetary shock across a spectrum of asset prices through time-series regression analysis with a focus on monetary policy announcement days. The relationship is captured by the equation:

$$\Delta y_{i,t} = \alpha_i + \beta_i e_t + \varepsilon_{i,t} \tag{4}$$

where $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$ denotes the changes in close rates, close yields, or close prices of asset i on monetary policy announcement day t, relative to the prior day $t-1$. e_t is the aligned PLS shock series, measured in percentage points. The OLS estimates of β along with robust standard errors are outlined in Table 4.

Panel (a) of Table 4 validates that our PLS shock series does exert a conventional signed impact on the NCD market, both in terms of primary issuance rates and secondary market trading yields. The results indicate that a 1 percentage point increase in the PLS shock causes a statistically significant 0.73pp rise in the 1-year NCD issuance rate of urban commercial banks. This particular rate maintains a one-to-one mapping relationship with the unobserved monetary policy shock. Additional columns provide insight into the impact on primary dealers' NCD issuance rates, exhibiting a pronounced "smirk" pattern, where the coefficient steadily decreases, reaches a statistically insignificant minimum at the 9-month NCD rate, and then rebounds to significance. This behavior is intuitive, given that monetary policy shocks tend to affect short-term funding conditions more prominently, with the peak at the 1-year mark potentially stemming from the fact that some urban commercial banks are authorized as primary dealers. The last four columns detail the yield-to-maturity for NCDs trading in the secondary market. While coefficients for all four maturities (3-month, 6-month, 9-month, and 1-year) are statistically significant, their magnitudes are smaller compared to the initial insurance impact.

Panel (b) of Table 4 explores the estimates for major inter-bank rates and highly traded interest rate swaps (IRS). Here, y denotes the rates in percentage points. The results highlight that a contractionary PLS shock of 1pp induces immediate, albeit statistically insignificant, movements in market rates. Specifically, a 1pp increase in the PLS shock leads to a

0.61pp to 0.84pp rise in the very short-term inter-bank rates, which corresponds to maturities of less than 1 month. Although the magnitudes is smaller for the medium-term market rate (Shibor3M), around 0.18pp, it becomes statistically significant. These outcomes align with the established fact that Chinese monetary policy primarily operates through the short-term inter-bank rates to propagate its impact. Similar significant impacts are observed for the rates of 1-year IRS on the 7-day repo rate (FR007(1Y)) and other IRSs like FR007(6M), Shibor3M(6M), and Shibor3M(1Y).

Panel (c) of Table 4 proceeds with estimates for bond yields. Each column corresponds to a particular bond maturity, while different rows reflect impact variations across debt assets. Notably, for treasury bonds, a positive monetary policy shock leads to an upward shift in the entire yield curve (ranging from 3-month to 30-year), with increases of 0.20pp to 0.42pp. These upward movements in the yield curve are mostly statistically significant, except for the less actively traded maturities (6-month and 9-month). Furthermore, examining the shock's impact on the yield curve of AAA-rated commercial bank bonds reveals a decreasing trend in both coefficient values and significance levels, varying from 0.61pp (significant at 1%) for 3-month to 0.20pp (insignificant) for 30-yr. maturity. Likewise, enterprise bonds exhibit a statistically significant upward shift of around 0.18pp to 0.41pp across AAA-rated yields, with all maturities (6-month to 30-year) yielding statistical significance. When moving to lower-rated bonds, the results remain robust, albeit the diminishing impact magnitudes. For corporate bonds, the yield curve experiences an upward shift in response to a positive monetary policy shock, with the largest increment being 0.24pp to 0.37pp for AAA and AA+ ratings, respectively. In summary, a mild smirk-shape along the yield curves of different debt assets in response to monetary policy shocks is detected.

Panel (d) of Table 4 presents estimates for several major stock market indexes from the Shanghai and Shenzhen stock exchanges. It's important to note that $\Delta y_{i,t}$ of Equation (4) now represents five-day cumulative returns, spanning from $t-1$ to $t+4$ around the monetary policy announcement days t. The findings indicate that positive monetary policy shocks do not generate immediate impacts on major stock valuations, but they do affect the group of innovative high-tech firms. Specifically, the ChiNext index, which focuses on innovative, fast-growing high-tech enterprises, experiences a decline of -28.13% in response to a 1pp monetary policy tightening. It is noteworthy that our findings on the short-term impacts of monetary policy shocks in China diverge from what is observed in the US market, where immediate stock price declines may be closely associated with responsive tightening interest rate changes.

Given that our PLS shock influences the 1-year NCD issuance rate of primary dealers (Primary(1Y)) and primary dealers' pivotal role in efficient monetary policy transmission through the inter-bank market, we test the robustness of our PLS shock's impact using IV regression where Primary(1Y) serves as the policy indicator. The regressions are as follows:

$$\begin{aligned} \Delta r_{\text{1-yr},t}^{\text{Primary}} &= \alpha_1 + \beta_1 e_t + \varepsilon_1 \\ \Delta y_{i,t} &= \alpha_{i,2} + \beta_{i,2} \Delta \hat{r}_{\text{1-yr},t}^{\text{Primary}} + \varepsilon_{i,2} \end{aligned} \tag{5}$$

The first stage regressions exhibit significantly robust F-statistics ranging from 6.50 to 9.26. Results are reported in Table 5, and all the aforementioned conclusions hold.

5.2. Dynamic Effects

We proceed to analyze the extended and dynamic effects of monetary shocks in China, focusing on the responses of interest rates and asset prices studied in the preceding subsection. Our approach employs local projection analysis (Jordà, 2005) over the full sample (2015-2021). We estimate the below panel specification:

$$y_{i,t+h} = \alpha_{i,h} + \beta_h e_t + \mathbf{\Gamma_h}'\mathbf{Y_{i,t}} + \varepsilon_{i,t+h}, h = 0, 1, 2, \cdots, H \tag{6}$$

Here, $\mathbf{Y_t} = [y_{i,t-1}, y_{i,t-2}, \cdots, y_{i,t-p}]$ are the lag-dependent variables with $p = 12$. The coefficients β_h capture the cumulative responses of various rates and asset prices to monetary policy shocks. Our focus spans $H = 30$ trading days to trace the dynamic repercussions of these policy shocks.

In terms of estimation, for the impulse responses of NCD issuance rates and yields, interbank market rates, interest rate swaps, treasury yields, and commercial bank bond yields, we employ straightforward local projection analysis, with α_h serving as a constant. However, we employ a panel local projection approach for credit bond yields of varying maturities (i.e., $i =$ AAA, AA+, AA) and for evaluating multiple stock market indexes, with α_h being the fixed effect. Throughout our analysis, we normalize the impact of monetary policy shocks to a 1 percentage point increase, that is, 1 percentage point contractionary shock.

Panel (a) of Figure 4 illustrates cumulative impulse response functions of NCD issue rates to contractionary PLS shocks, represented by the solid black line. The deep and shallow blue areas correspond to 68% and 90% confidence interval bands, respectively, generated using Newey-West standard errors. Notably, due to the assumed one-to-one mapping of PLS shocks with and normalization to the 1-year NCD issue rate of urban commercial banks, we observe that Urban(1Y) responds significantly, experiencing a rise of 1.12pp and peaking at 1.73pp on the following day. Similarly, the 1pp shock induces a rise in the issuance rate of 1-year NCD for both primary dealers and non-primary dealers, with peaks of 1.52pp (on the fifth day) and 1.74pp (on the first day), respectively. These responses remain significant for approximately six trading days. The 3-month NCD issue rates of urban commercial banks exhibit a larger and relatively longer-lasting response, peaking at 3.74pp on the third day and persisting until the eighth trading day. This outcome aligns with the fact that Chinese monetary policy predominantly operates through the NCD market via short-term rates.

Panel (b) of Figure 4 presents local projection-based impulse responses of the inter-bank market rates to positive PLS shocks. This includes yields-to-maturity of tradable NCDs, major market rates, and heavily traded IRSs. Firstly, we observe that a 1pp contractionary PLS shock also triggers immediate shifts in the yields of tradable NCDs, such as the 3-month and 1-year AAA+-rated NCDs, as well as 1-year AAA-rated NCDs. Analogous to the primary issuance market results, the notable upward shift of short-term (3-month) yields extends longer than that of longer maturities (1-year), lasting 12 days compared to 7 days, and with a larger peak magnitude (1.74pp versus 1.12pp). Secondly, the 1pp increase in unexpected policy rates prompts a 1.29pp rise in the 7-day repo rate (DR007) on the next day, remaining significant for around 2 days before subsiding. By contrast, a substantial and immediate impact emerges in response to positive monetary policy shocks on the 3-month Shibor rate (Shibor3M), which takes a longer 15 trading days to reach its peak response of 1.41pp before diminishing. Thirdly, the responses of IRSs are comparatively smaller and briefer. Positive reactions of the 1-year and 5-year IRS on DR007 persist for 2 days, exhibiting peak impacts of 0.47pp and 0.44pp respectively. In contrast, IRSs on Shibor3M (both 1-year and 5-year) present larger peak impacts (0.57pp and 0.48pp) and longer significant durations.

Panel (c) of Figure 4 presents the panel impulse responses encompassing 36 stock market indexes. Robust standard errors, clustered at the index and month level, are reported. Specifically, stock prices start declining on the day of a positive monetary policy shock, achieving statistical significance on the subsequent day. This trend of declining prices continues insignificantly for the following 12 days. Crucially, after a two-week period, the declines intensify in significance, persisting throughout the entire month. This sequence of events implies a weak short-term transmission of interest rate shocks into asset prices via the direct financing channel. However, our findings suggest that monetary policy transmission eventually extends to other market segments, albeit with some time lag. Further investigation reveals that stocks listed on the Shenzhen Stock Exchange (SZI) display greater sensitivity to unexpected contractionary monetary policy compared to those on the Shanghai Stock Exchange (SSEC). Moreover, responsiveness and scale decrease with respect to stock size. Specifically, while small stocks' prices (CSI1000) exhibit significant negative responses, those of large stocks (CSI100) decrease insignificantly. In line with the previous subsection's findings, fast-growing high-tech firms (ChiNext) demonstrate quicker and more substantial responses.

Panel (d) of Figure 4 illustrates impulse responses of treasury yields to unexpected rate increases in China, considering treasury bond yields across different maturities (3-month, 6-month, 1-year, 3-year, 5-year, and 10-year). Our results indicate that policy interest rate hikes generate significantly positive reactions in treasury markets. Notably, the overall responses of treasury yields are relatively weak, with an average response peak of 0.63pp across maturities and a decline within approximately 5 days. This evidence again supports the assertion that Chinese monetary policy shocks are primarily transmitted through the banking channel, while the efficacy of open market operations involving treasury bonds for initiating policy impacts remains limited. Panel (e) of Figure 4 depicts impulse responses of AAA-rated commercial bank bonds' yields across the same 6 maturities. A tightening monetary policy shock results in an average peak response of 1.02pp, lasting for an average of 7.5 days.

Panel (f) and Panel (g) detail the panel impulse responses of enterprise and corporate bonds' yields categorized by different credit ratings (AAA, AA+, and AA). Across the corporate bonds and enterprise bonds asset class, we find similar dynamic impacts of monetary policy shocks. Key observations include: (1) Policy rate shocks of 1pp lead to significant increases in the yields of 6-month, 1-year, and 5-year enterprise (corporate) bonds, peaking at 0.83pp (0.71pp), 0.59pp (0.52pp), and 0.45pp (0.56pp), respectively. These effects diminish over a span of about 12 days. (2) The reactions of 3-year and 7-year bonds to policy rate hikes are more muted, with maximum increases of around 0.36pp (0.39pp) and significant effects lasting only 8 days. (3) Longer-term bonds (10-year for enterprise bonds and 9-year for corporate bonds) exhibit persistent impacts over the entire observational month, albeit becoming statistically insignificant after 9 days. These shock impacts peak at 0.30pp and 0.34pp for enterprise and corporate bonds, respectively. We further validate the impact of our PLS shock using IV regression, where Primary(1Y) serves as the policy indicator. The results are provided in Figure 6, confirming the robustness of our findings.

In summary, our empirical findings robustly suggest the efficacy of interest rate-based monetary policy transmission in China. This not only confirms that China's monetary policy transmission is primarily facilitated through the inter-bank market of the banking channel but also underscores that the market recognizes the increasing advantages of liberalized interest rates. Consequently, market segments move collectively in the desired direction, despite variations in the speed of their reactions.

5.3. Transmission into the Real Economy

After thoroughly investigating the immediate and dynamic impact of monetary policy on financing costs across diverse financial sectors, we turn our attention to its ramifications on real economic activity. We adopt a standard monthly VAR model with 2 lags, positioning our cumulative monetary policy shock series first. This arrangement enables our shock to contemporaneously influence inflation, output, and credit spread, using both Cholesky identification and Bayesian estimation with conjugate Minnesota priors. Specifically, we gauge inflation through the year-on-year growth percentage of the producer price index (PPI), output is quantified by the year-on-year growth rate of industrial value added (IVA). Both variables are sourced from the National Bureau of Statistics of China and collected via the Wind dataset. Credit spread is calculated as the difference between the yields of 1-year AAA-rated enterprise bonds and 1-year treasury yields. Our analysis outcomes are presented in Figure 5.

In Panel (a), we observe that in the Cholesky-identified VAR model, inflation experiences a decrease following a monetary policy tightening while output decreases after two months, albeit without statistical significance. Notably, the responses of output trough after about 5 months versus that of inflation trough after 10 months. In the case of Bayesian VAR estimation, both inflation and output exhibit immediate declines after a contractionary monetary policy shock, with inflation experiencing a significant drop. Furthermore, when credit spread is added to the VAR system, Panel (b) under Cholesky identification reveals that credit spread surges and peaks around 6 months post-monetary policy tightening. The responses of inflation and output remain similar to those of a three-variable VAR, despite the inclusion of credit spread. These findings align with conventional expectations and echo Gertler and Karadi (2015).

Finally, it is important to note that in Sections C and D of the Internet Appendix, we compare our estimation results of the impacts of monetary policy surprises on asset prices and the macro aggregates against those if using other existing measures, which are derived from different research focuses and of different data construction frequencies (Chen, Ren, and Zha, 2018; Xu and Jia, 2019). Relative to these very high bars, it can be shown that our estimations generate robustly right-signed monetary policy transmission dynamics in different markets and aggregates, which are well consistent with the established theoretical predictions on the causal effects of monetary policy changes (e.g. Christiano, Eichenbaum, and Evans (1999) and Gilchrist, López-Salido, and Zakrajšek (2015)). By contrast, in response to unexpected monetary tightening as captured by these other measures, counter-intuitively, the bond yields appear to drop whereas the stock market indexes jump.

6. Conclusion

This paper fills an important gap in the literature by presenting a two-step, easy-to-implement estimation procedure that identifies monetary policy surprises in emerging markets using higher-frequency financial data. We apply this methodology to China's market setting, given its complex, multi-dimensional, and evolving monetary policy regime, which is shared by many other emerging market economies. Our approach enables us to obtain the common component of interest rate variations across maturities driven by monetary policy changes of different policy tools. This delivers a high-frequency measure of Chinese monetary policy shocks, which is a parsimonious and single time series that can be used to study several critical questions about Chinese markets.

Our paper is therefore first to identify the causal impacts of changes in Chinese monetary policy on asset prices in China up to daily frequency. We show that our identified monetary policy shocks significantly shift the treasury rates, corporate bond yields, and equity prices. Our estimations, based on a VAR system including our shock series, demonstrate that Chinese monetary policy shocks generate the expected impacts on macroeconomic aggregates, which is consistent with established theory predictions.

Most importantly, our methodology accommodates the evolving nature and institutional complexity of monetary policy practices in emerging markets, which have brought multiple objectives and a diverse universe of policy tools into the monetary policy decision-making paradigm. As long as any form of financial data of an economy is available up to daily frequency, our methodology is adaptable to any inclusion or exclusion of a specific policy tool in the real practice of monetary policy.

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Tables and Figures

Table 1. Summaries of Announcement Timing

(a) Day of Month Distribution of Announcements

	Min	P25	Median	P75	Max	Mode	No. Events
MLF	3	13	15	17	30	15	104
LPR	20	20	20	20	20	20	6
RRR	1	4	8	23	29	4 & 6	14
BLR	1	11	23	25	28		5
RevRepo	3	14	18	25	30	3	17

Note: This table displays the distribution of announcements based on their percentile cut-off day within a month, spanning from January 2015 to December 2021. The numerical value i within each cell corresponds to the i-th day of the month. Min: The earliest day of the month identified as an announcement day. Max: The latest day of the month for an announcement event. Percentiles: Percentile values of the day of month distribution. Mode: The day of the month with the highest frequency of announcements.

(b) Day of Week Distribution of Announcements

	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
MLF	23.08	19.23	20.19	14.42	20.19	2.88	
LPR	33.33	16.67	16.67	16.67	16.67		
RRR	14.29	14.29	14.29		35.71		21.43
BLR	20.00	20.00			20.00		40.00
RevRepo	17.65	41.18		35.29	5.88		

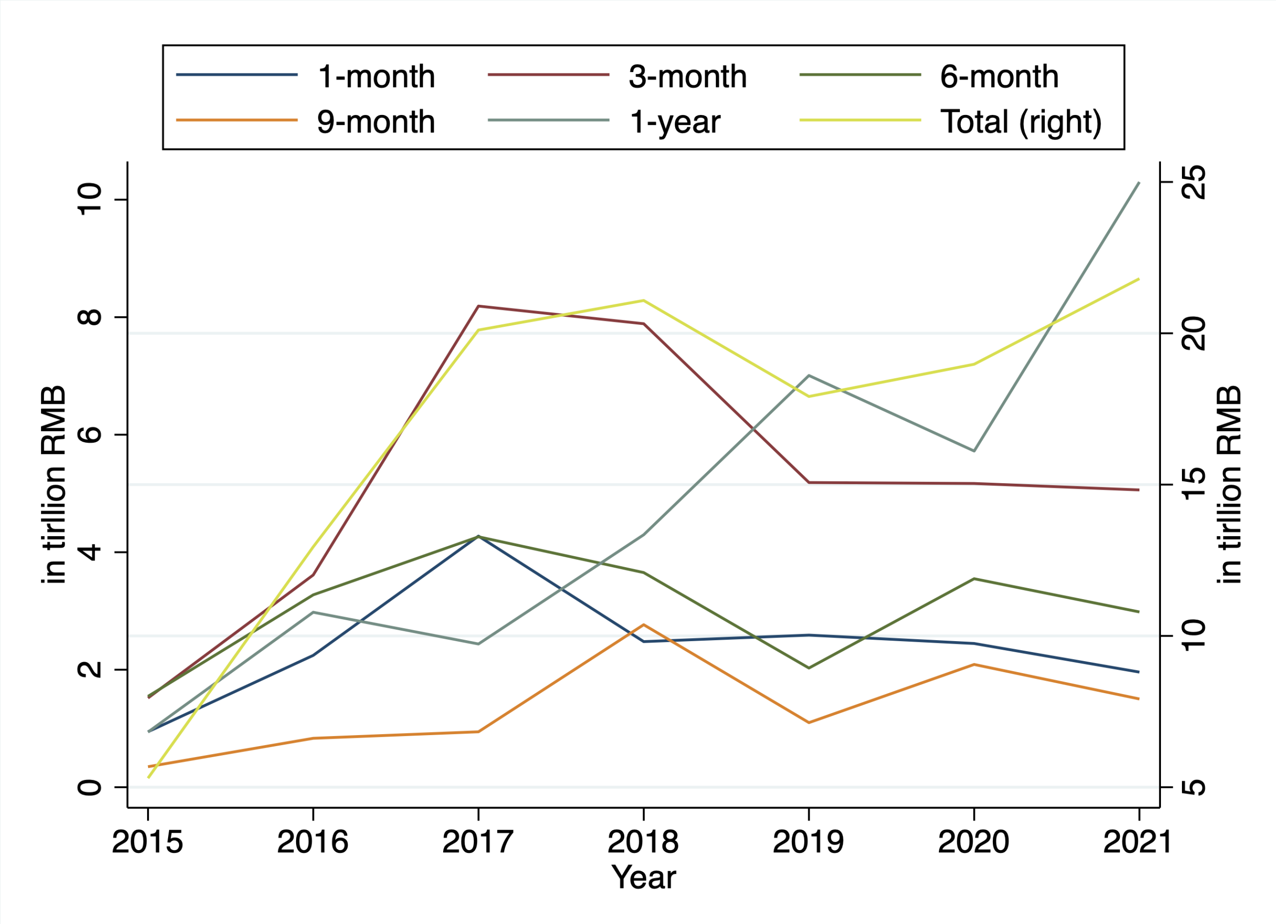
Note: This table illustrates the distribution of announcements as percentages (expressed in decimal form) for each day of the week associated with a given announcement. Due to rounding, the column totals might not sum up exactly to one.

(c) Timing Distribution of Announcements

	Weekday within Trading Hours		Mon-Thur after Trading hours		On Weekends	
	No. Anns.	Avg. Time	No. Anns.	Avg. Time	No. Anns.	Avg. Time
MLF	82	10:48:59	17	17:56:46	5	17:02:59
LPR	6	9:30:00				
RRR	3	16:21:49	4	18:15:50	7	16:43:36
BLR			3	18:17:12	4	16:53:45
RevRepo	17	9:47:56				

Note: This table presents the count of announcement events categorized by timing groups, along with the average time of day for announcement releases within each group. The three defined groups include: (1) announcements released during trading hours; (2) announcements released after trading hours from Monday to Thursday; and (3) announcements released between market closure on Friday until midnight on Sunday. The T + 1 trading hours for money, bond, and inter-bank markets on CFETS is 9:00-12:00p.m. and 1:30-5:00p.m..

Fig. 1. NCD Total Issuance Amount by Maturities across Years



Note: The figure illustrates the aggregate annual issuance amount of NCDs in trillion RMB over a span of five maturities from 2015 to 2021. The issuance amount corresponding to each maturity is synchronized with the left y-axis, while the total issuance amount is synchronized with the right y-axis.

Table 2. Summary Statistics of NCD Issuance

Issuer Type	Num of Issuers	Stat	Maturity (months) 1	3	6	9	12	Total Value
Urban Commercial Bank	121	Mean	6.65	5.86	4.96	3.97	4.96	5.32
		S.D.	9.98	9.10	7.83	7.15	8.63	8.70
		N	13,188	19,321	17,610	9,271	24,413	83,803
Rural Commercial Bank	596	Mean	2.90	3.50	3.73	2.99	3.80	3.39
		S.D.	3.27	4.86	5.05	3.97	4.98	4.49
		N	10,721	11,053	7,932	2,482	5,599	37,787
Joint-Stock Commercial Bank	12	Mean	11.69	19.49	14.28	12.60	18.97	16.64
		S.D.	17.67	31.65	25.81	22.93	29.37	27.84
		N	3,368	9,028	5,392	3,258	7,237	28,283
State-Owned Commercial Bank	6	Mean	14.14	25.48	25.46	20.15	38.86	28.37
		S.D.	22.04	44.34	46.55	42.48	57.02	48.42
		N	336	1,250	560	471	1,324	3,941
Foreign-Invested Bank	29	Mean	6.10	4.16	3.37	2.44	3.70	4.10
		S.D.	11.37	4.56	4.40	2.27	4.30	6.15
		N	293	667	438	118	261	1,777
Private Bank	15	Mean	3.13	1.49	1.19	0.96	1.27	1.67
		S.D.	5.37	2.43	1.81	1.35	1.91	3.11
		N	310	414	278	85	461	1,548
Others	67	Mean	1.28	2.36	1.73	1.23	0.92	1.72
		S.D.	1.45	3.34	2.35	1.28	0.63	2.48
		N	173	209	118	34	47	581
Total	846	Mean	5.85	8.67	6.50	6.06	8.46	7.40
		S.D.	10.17	19.09	14.44	14.65	19.52	16.62
		N	28,389	41,942	32,328	15,719	39,342	157,720

Note: This table presents summary statistics, mean and standard deviation, for the actual issuance amount of NCDs in units of 100 million RMB, as well as the number of NCDs issued (N), categorized by issuer types and maturities.

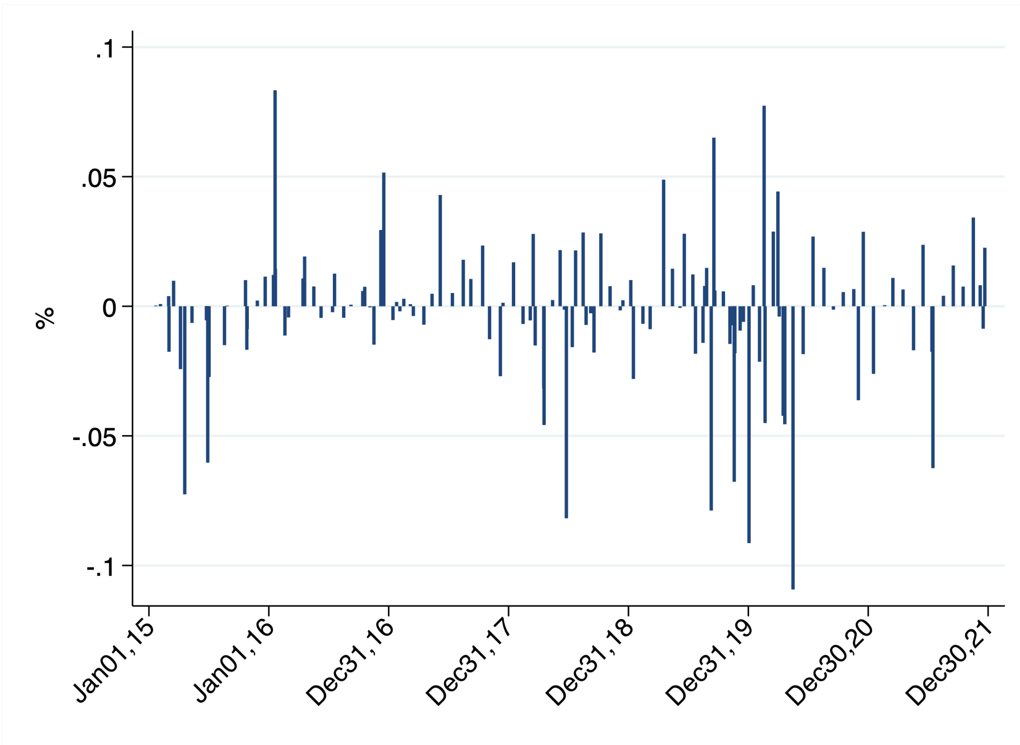
Table 3. Movements in NCD Issuance Rates

Isssuer Type		SOCB					UCB					RCB					JSCB				
Maturities (months)		1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12
LPR	Mean (bps)	3.33	2.97	2.56	1.28	5.17	13.65	27.27	17.95	13.54	6.96	11.51	11.15	8.16	4.26	21.30	2.49	6.21	5.68	7.60	2.22
	Std. Dev. (%)	8.16	3.92	3.78	1.95	6.88	14.27	31.06	16.16	7.44	6.10	18.82	7.83	5.28	6.35	21.69	4.08	5.35	5.11	10.85	2.04
BLR	Mean (bps)	0	15.00	0		0	13.86	1.32	15.76	0.23	7.04	5.15	4.54	5.25	0	11.70	6.03	8.43	6.66	2.65	2.90
	Std. Dev. (%)	0	33.54	0		0	23.89	1.91	26.19	0.51	7.33	10.07	7.55	11.75	0	14.06	8.95	6.92	9.34	5.13	6.21
RRR	Mean (bps)	5.21	4.59	3.21	0	1.35	7.87	6.20	16.09	9.50	11.64	9.29	6.43	16.92	14.86	13.76	4.94	11.41	13.29	13.15	10.61
	Std. Dev. (%)	13.67	12.02	7.48	0	2.86	6.76	8.04	27.64	11.40	13.23	8.46	6.47	20.61	22.60	16.74	8.34	12.05	14.35	16.10	16.19
RevRepo	Mean (bps)	0	3.82	2.06	6.19	1.78	13.39	12.61	7.58	5.93	5.97	7.42	8.34	6.95	9.54	9.18	14.34	4.70	4.07	4.10	4.31
	Std. Dev. (%)	0	7.70	8.49	11.62	4.97	21.18	19.22	7.35	7.75	6.39	10.49	9.04	9.04	15.14	20.01	19.69	5.97	5.21	6.51	4.10
MLF Rate Change	Mean (bps)	7.36	0.81	0	0.54	0.71	6.73	5.82	13.14	9.59	6.87	7.29	7.38	4.79	9.41	14.66	4.68	3.96	4.39	3.03	4.39
	Std. Dev. (%)	25.85	2.66	0	1.45	2.62	6.54	7.62	20.31	19.05	6.81	7.61	5.78	5.52	14.21	22.60	10.42	3.81	6.09	5.61	3.34
MLF	Mean (bps)	2.85	3.11	1.74	0.89	1.19	5.50	7.53	7.50	6.56	5.98	7.26	7.69	7.77	10.19	7.26	5.80	5.29	4.47	4.23	5.35
	Std. Dev. (%)	10.15	6.07	4.77	2.76	2.98	6.48	10.44	8.46	8.51	6.50	9.63	8.97	8.31	20.28	7.64	7.82	11.24	6.36	7.25	7.66
All Events	Mean (bps)	3.24	3.58	1.80	1.13	1.40	7.58	8.73	9.86	7.35	6.84	7.65	7.66	8.28	10.18	9.76	6.69	5.93	5.47	5.19	5.45
	Std. Dev. (%)	12.35	9.12	5.41	3.82	3.44	10.97	13.35	14.30	10.27	7.60	9.91	8.36	10.37	19.00	13.86	10.58	10.27	7.86	8.83	8.30
Uneventful Days	Mean (bps)	2.36	2.52	1.53	1.24	1.42	8.22	8.08	8.82	8.34	7.95	7.88	8.04	8.11	8.97	9.93	6.57	4.62	4.87	3.60	4.03
	Std. Dev. (%)	11.70	6.98	7.12	5.34	3.99	11.54	10.99	14.07	11.36	10.89	10.87	9.98	10.78	16.92	14.01	13.80	8.12	7.38	7.33	6.33

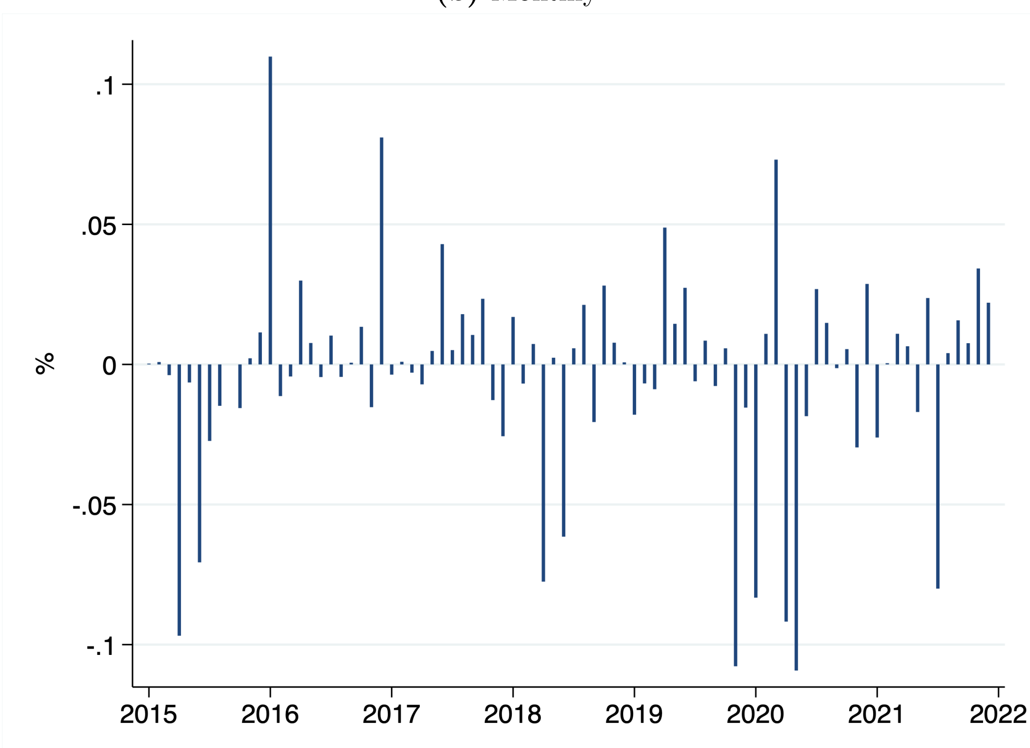
Note: This table reports descriptive statistics for the absolute changes in the 20 NCD issuance rates across 4 main issuer types and 5 distinct maturities, in relation to both days with each monetary policy announcements and days without any monetary policy announcements. The issuer types are categorized as follows: SOCB (state-owned commercial bank), UCB (urban commercial bank), RCB (rural commercial bank), and JSCB (joint-stock commercial bank).

Fig. 2. Interest-Rate Based Chinese Monetary Policy Shock Series (Jan2015 to Dec2021)

(a) Daily

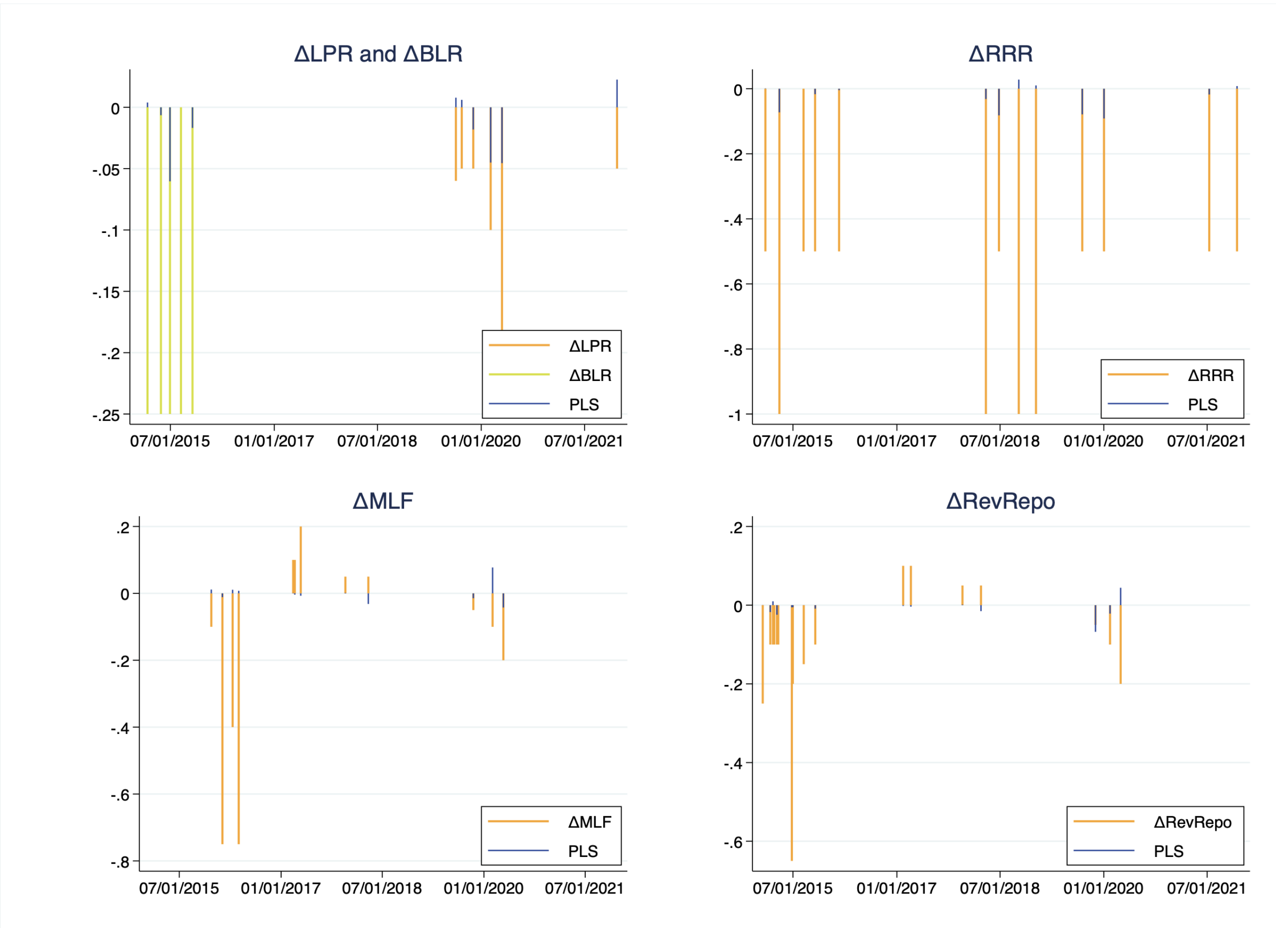


(b) Monthly



Note: Time series of Chinese monetary policy shock estimated through heteroskedasticity-based partial least squared (PLS) regressions with instrumental variables (IV). This specific shock series is henceforth denoted as "PLS" shock.

Fig. 3. Monetary Policy Shock Series v.s. Changes in Monetary Instruments



Note: The PLS shock is juxtaposed against changes in each underlying monetary instrument. "LPR" denotes the loan prime rate, "BLR" denotes the benchmark lending rate, "RRR" denotes the required reserve ratio, "MLF" denotes the medium-term lending facility rate, and "RevRepo" denotes the 7-day reverse repo rate.

Table 4. Shock On Impact

(a) NCDs' Issue Rates & Yields (%)

		Primary Dealer's Issue Rate					Yields-to-Maturity			
	Urban(1Y)	1M	3M	6M	9M	1Y	AAA+(3M)	AAA+(6M)	AAA+(9M)	AAA+(1Y)
e_t	0.7310*	1.2951**	1.2271***	0.8261*	0.5333	0.6199**	0.2919**	0.2999*	0.3568**	0.2545*
	(0.3801)	(0.6335)	(0.4236)	(0.4439)	(0.3770)	(0.2433)	(0.1359)	(0.1580)	(0.1477)	(0.1470)
Constant	-0.0088	-0.0180	-0.0063	-0.0128	-0.0099	0.0003	-0.0036	-0.0057	-0.0068*	-0.0060*
	(0.0086)	(0.0126)	(0.0077)	(0.0083)	(0.0074)	(0.0062)	(0.0049)	(0.0042)	(0.0037)	(0.0034)
N	124	117	131	126	108	127	133	133	133	133
adj. R^2	0.03	0.06	0.13	0.05	0.02	0.05	0.02	0.02	0.05	0.03

(b) Inter-bank Market Rates (%)

	DR007	DR014	ShiborON	Shibor3M	FR007(1Y)	FR007(5Y)	Shibor3M(1Y)	Shibor3M(5Y)
e_t	0.6577	0.8400	0.6184	0.1812**	0.2566*	0.2661**	0.3446**	0.3298**
	(0.4973)	(0.8317)	(0.4355)	(0.0752)	(0.1412)	(0.1307)	(0.1563)	(0.1559)
Constant	0.0022	0.0154	0.0056	-0.0029*	-0.0119***	-0.0097***	-0.0158***	-0.0158***
	(0.0085)	(0.0178)	(0.0123)	(0.0017)	(0.0033)	(0.0031)	(0.0039)	(0.0042)
N	133	133	133	133	133	133	133	133
adj. R^2	0.03	0.01	0.01	0.06	0.03	0.03	0.04	0.03

(c) Bonds' Yields (%)

	3M	6M	9M	1Y	3Y	5Y	7Y	9Y	10Y	15Y	30Y
Treasury	0.3217**	0.1965	0.1957	0.3358***	0.3965***	0.4221***	0.2881***	0.2802***	0.2765***	0.3324***	0.3244**
	(0.1410)	(0.1466)	(0.1320)	(0.1186)	(0.1297)	(0.1087)	(0.1076)	(0.0931)	(0.0946)	(0.0988)	(0.1247)
Commercial(AAA)	0.6126***	0.8180***	0.6426**	0.4929**	0.3546**	0.2629**	0.2163*	0.2098*	0.1842	0.1695	0.2006
	(0.2084)	(0.2645)	(0.2473)	(0.2130)	(0.1433)	(0.1308)	(0.1178)	(0.1184)	(0.1232)	(0.1240)	(0.1230)
Enterprise(AAA)		0.4177***		0.3808***	0.3068**	0.3200***	0.2414**	0.1947*	0.2331**	0.1779**	0.1855*
		(0.1478)		(0.1414)	(0.1419)	(0.1216)	(0.1105)	(0.1050)	(0.0930)	(0.0891)	(0.1090)
Enterprise(AA+)		0.2179*		0.2660**	0.2050*	0.1713	0.1444	0.0899	0.1316	0.1403*	0.1008
		(0.1248)		(0.1129)	(0.1138)	(0.1039)	(0.0932)	(0.0954)	(0.0956)	(0.0833)	(0.0937)
Corporate(AAA)		0.1993		0.2184*	0.2013*	0.2440**	0.2152**	0.2121*			
		(0.1241)		(0.1120)	(0.1157)	(0.1034)	(0.1066)	(0.1137)			
Corporate(AA+)		0.3069**		0.3657***	0.2920**	0.2503*	0.2541**	0.2125*			
		(0.1513)		(0.1378)	(0.1400)	(0.1305)	(0.1239)	(0.1263)			

(d) Stock Market Returns $[t+4, t-1]$ (%)

	SSEC	SSEA	SSEB	CSI300	SZI	ChiNext	SZSE100R	SMEC
e_t	-4.2121	-4.2096	-4.2876	-4.2931	-8.2060	-28.1295*	-8.8091	-9.0141
	(11.0174)	(11.0203)	(12.2615)	(10.8079)	(13.8062)	(15.5456)	(12.4298)	(14.9212)
Constant	-0.7156**	-0.7160**	-0.5502	-0.6967**	-0.9864***	-1.0137**	-0.7627**	-0.7806**
	(0.3219)	(0.3220)	(0.3817)	(0.3310)	(0.3759)	(0.4062)	(0.3545)	(0.3937)
N	133	133	133	133	133	133	133	133
adj. R^2	-0.01	-0.01	-0.01	-0.01	-0.00	0.02	-0.00	-0.00

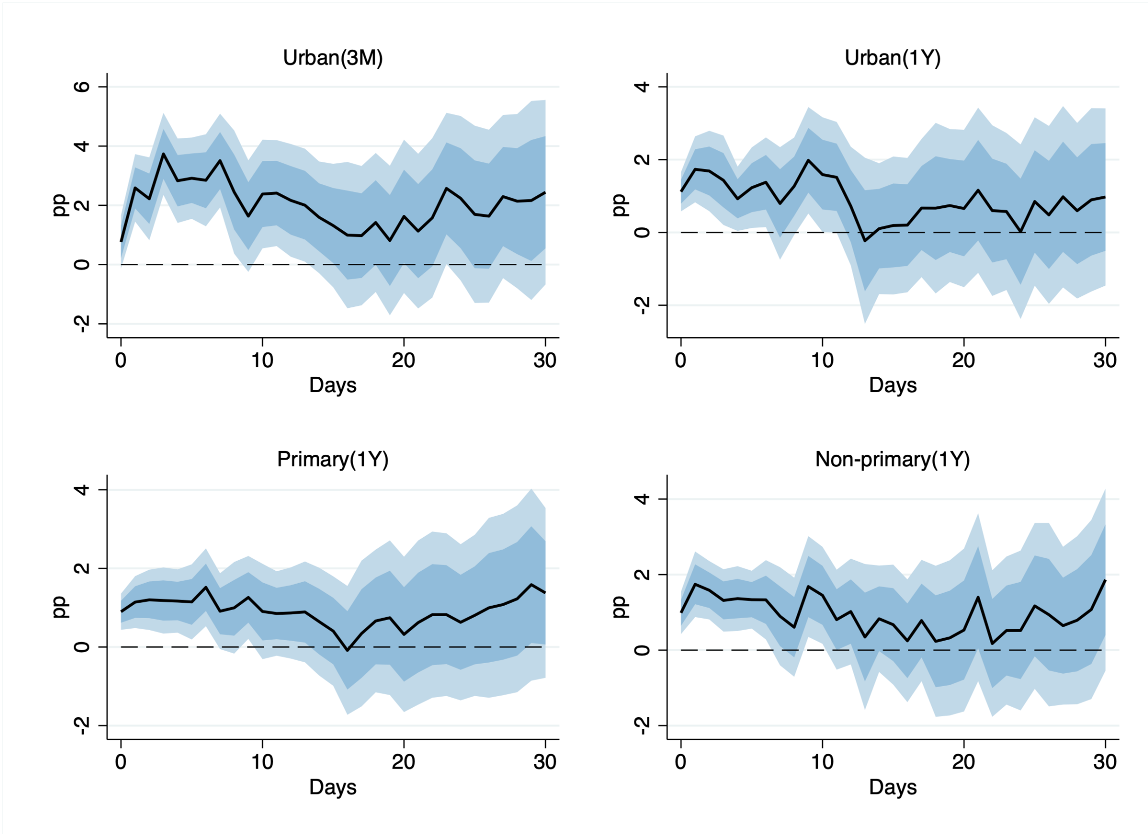
Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

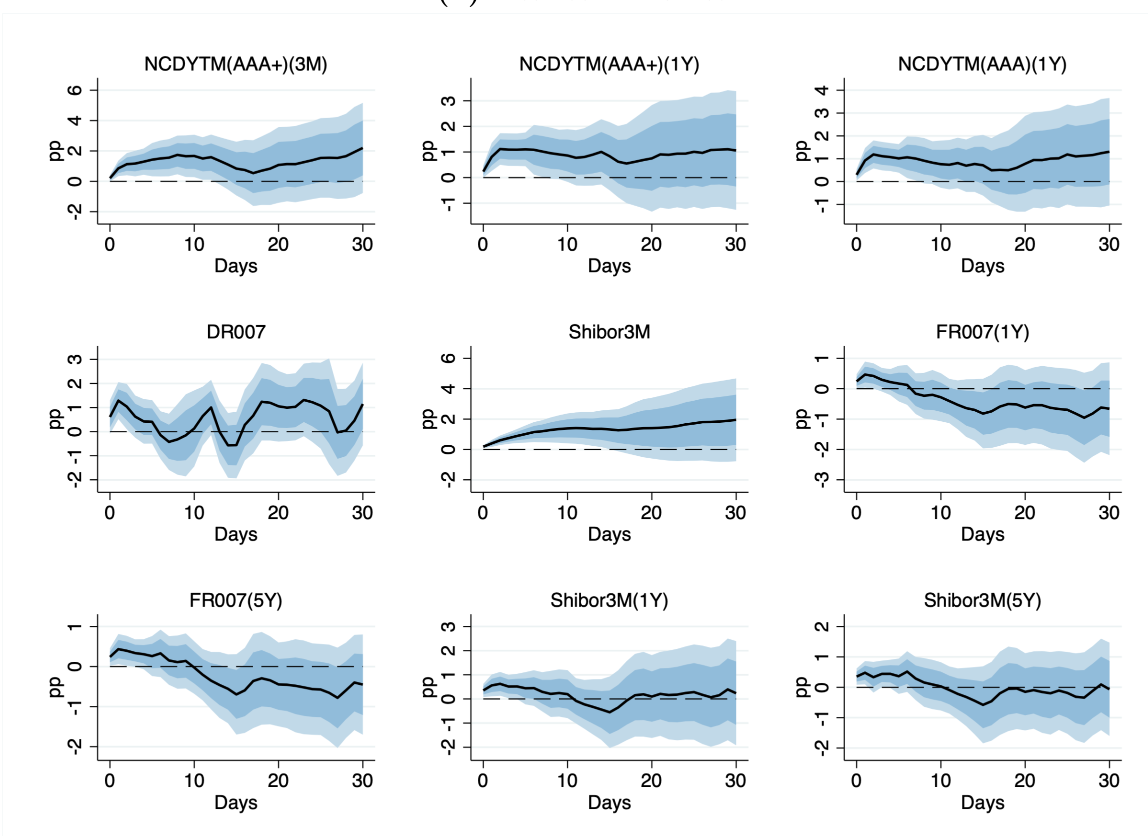
Note: This table presents the impact of 1 percentage point contractionary "PLS shock" on an array of financial products, as per the specification outlined in Equation (4), except for the effect on stock market indexes. In the context of stock market indexes, $\Delta y_{i,t} = y_{i,t+4} - y_{i,t-1}$ denotes the cumulative 5-day stock returns expressed in percentage terms.

Fig. 4. Impulse Responses - Local Projection

(a) NCD Issuance Rates

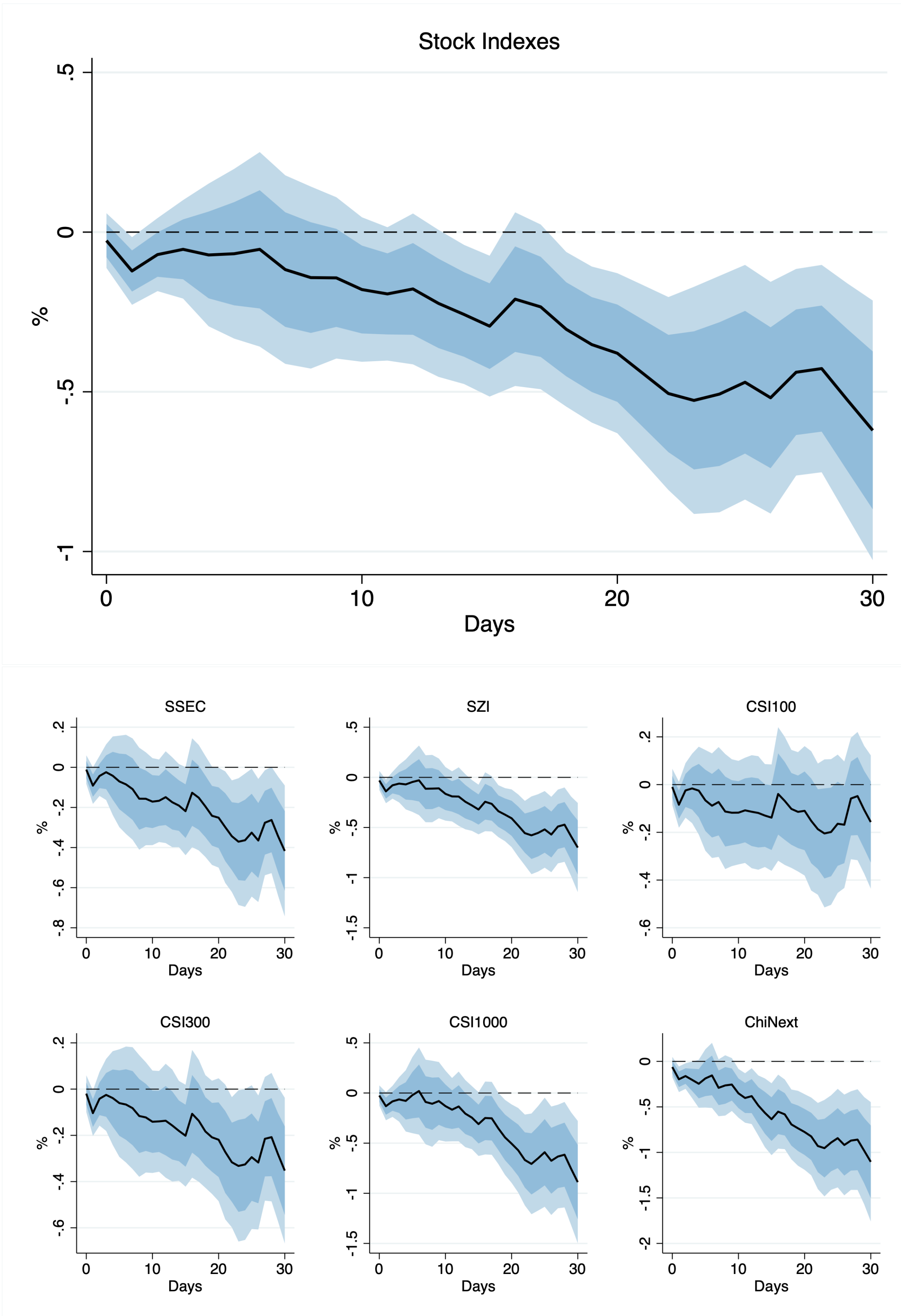


(b) Inter-bank Market



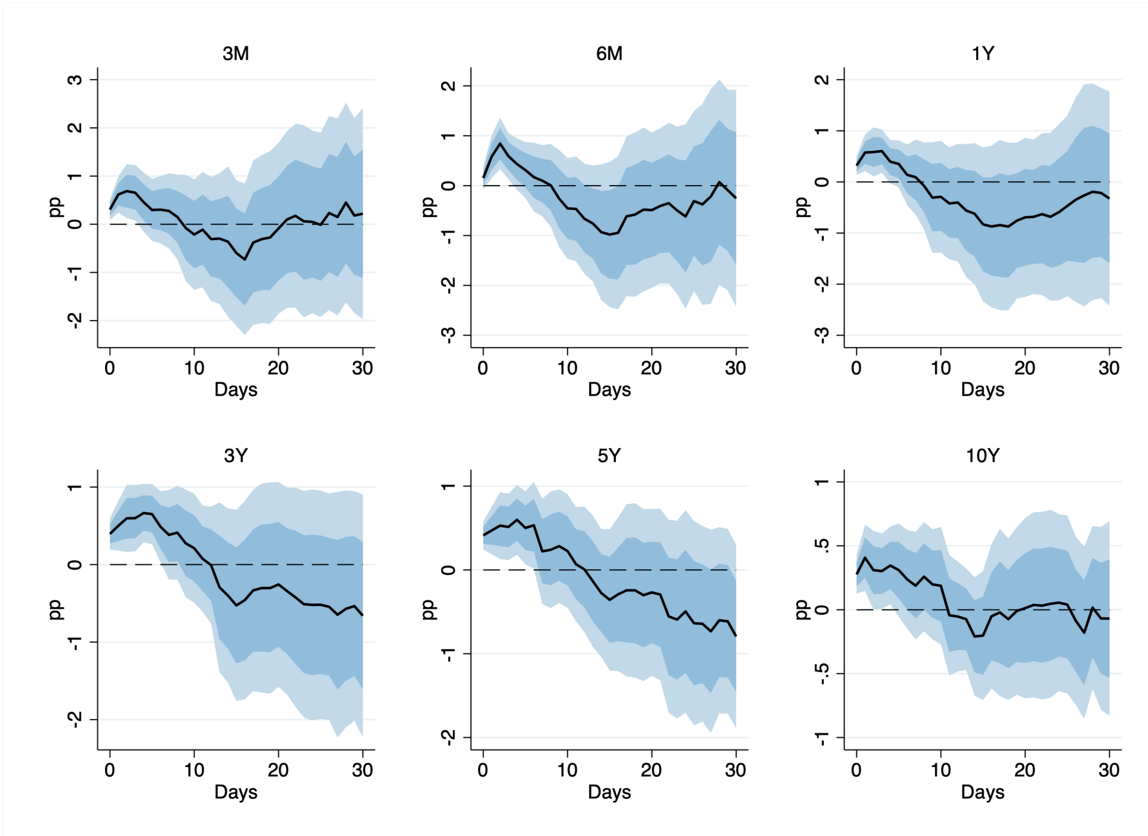
Note: Cumulative impulse response functions to a 1 percentage point increase in the PLS shock series. Deep and shallow blue shaded areas are 68% and 90% confidence intervals produced by Newey-West standard errors.

(**c**) Stock Market

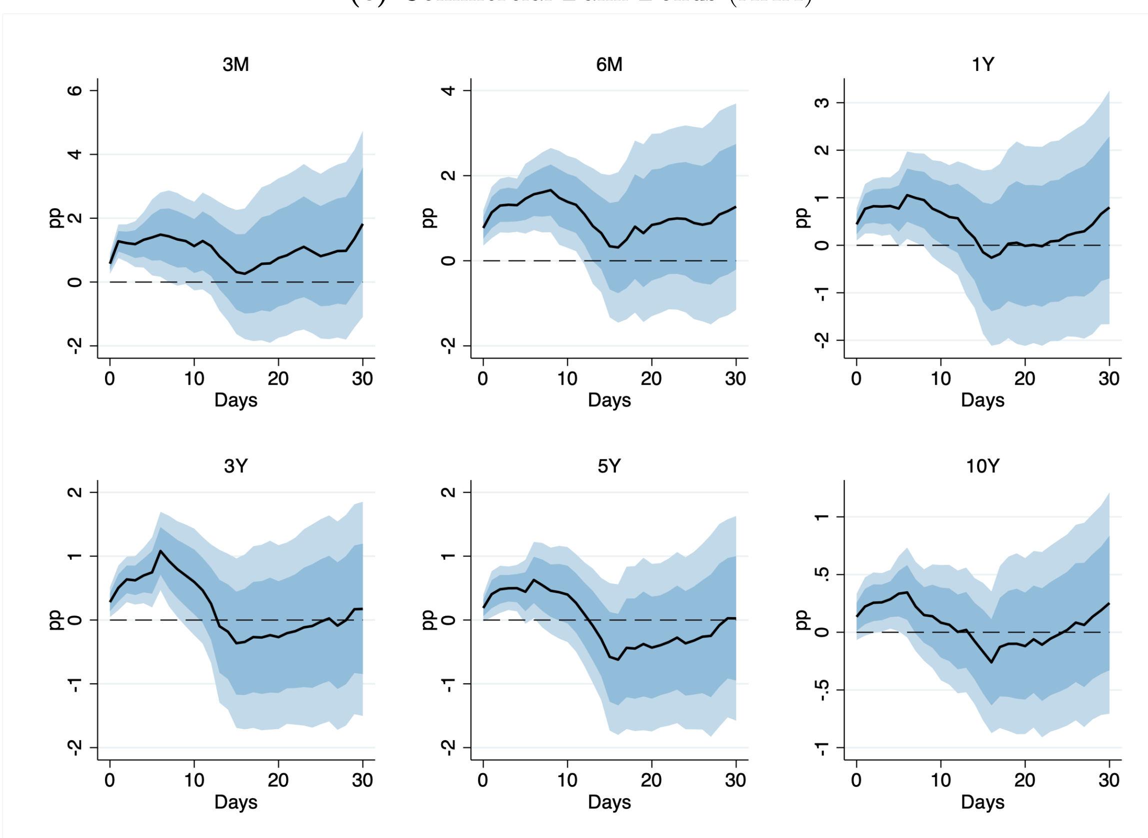


Note: The upper panel reports the panel impulse response functions of prominent stock market indexes to a 1 percentage point increase in the PLS shock series. Deep and shallow blue shaded areas are 68% and 90% confidence intervals generated by standard errors clustered at both month and index levels. The lower panel report the impulse response function for individual stock market indexes, with confidence intervals calculated using Newey-West standard errors.

(d) Treasuries

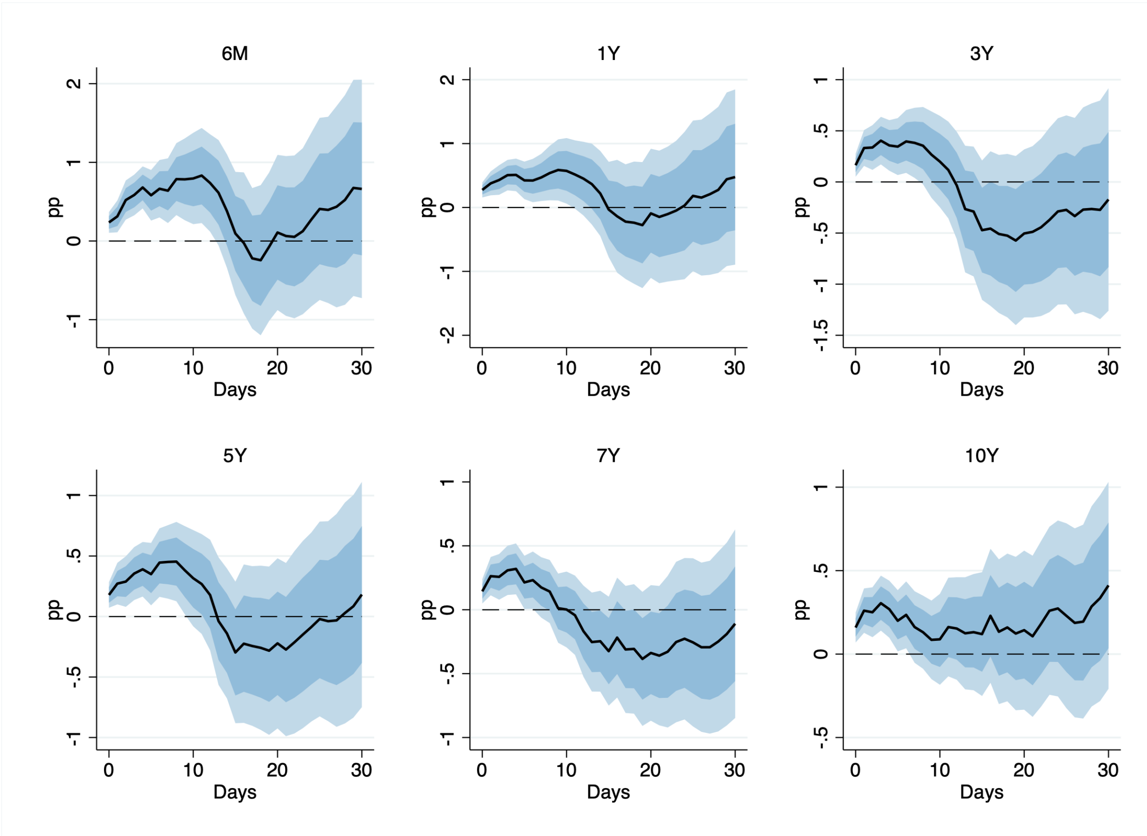


(e) Commercial Bank Bonds (AAA)

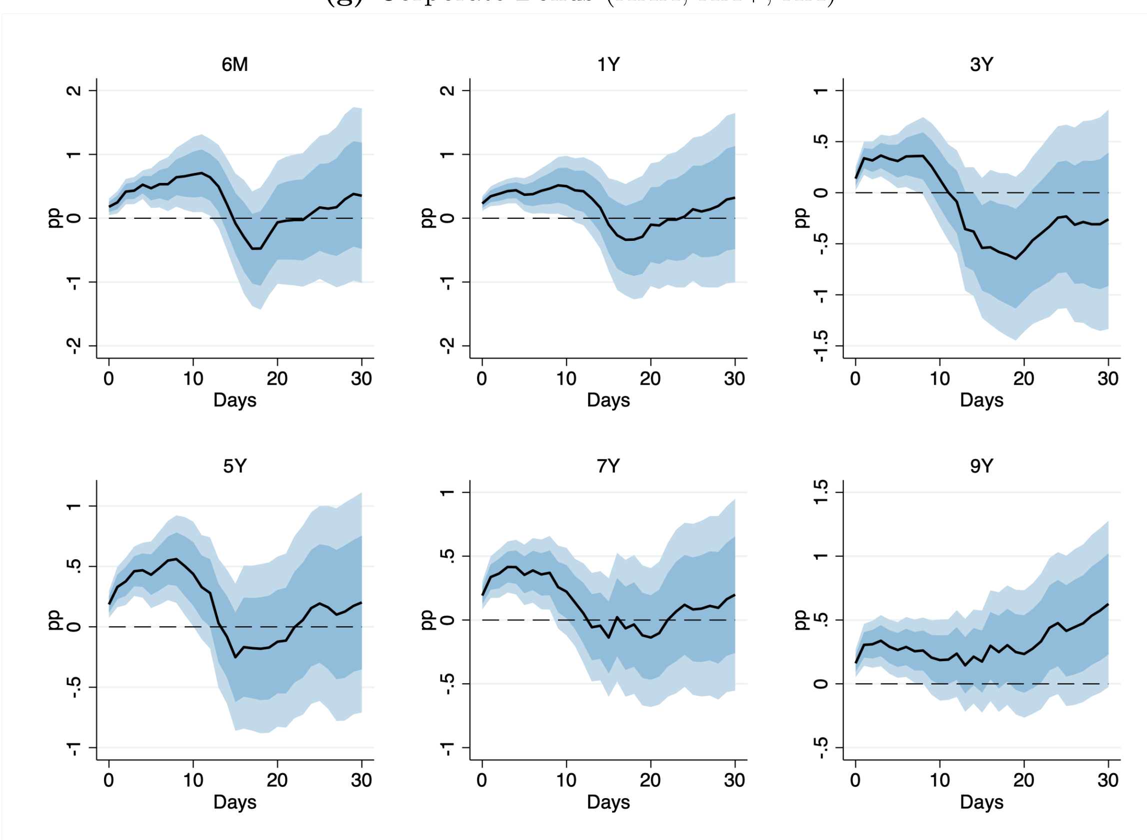


Note: The upper (lower) panel reports the impulse response functions of treasury yields (AAA-rated commercial bank bonds) to a 1 percentage point increase in the PLS shock series. Deep and shallow blue shaded areas are 68% and 90% confidence intervals generated by Newey-West standard errors.

(f) Enterprise Bonds (AAA, AA+, AA)



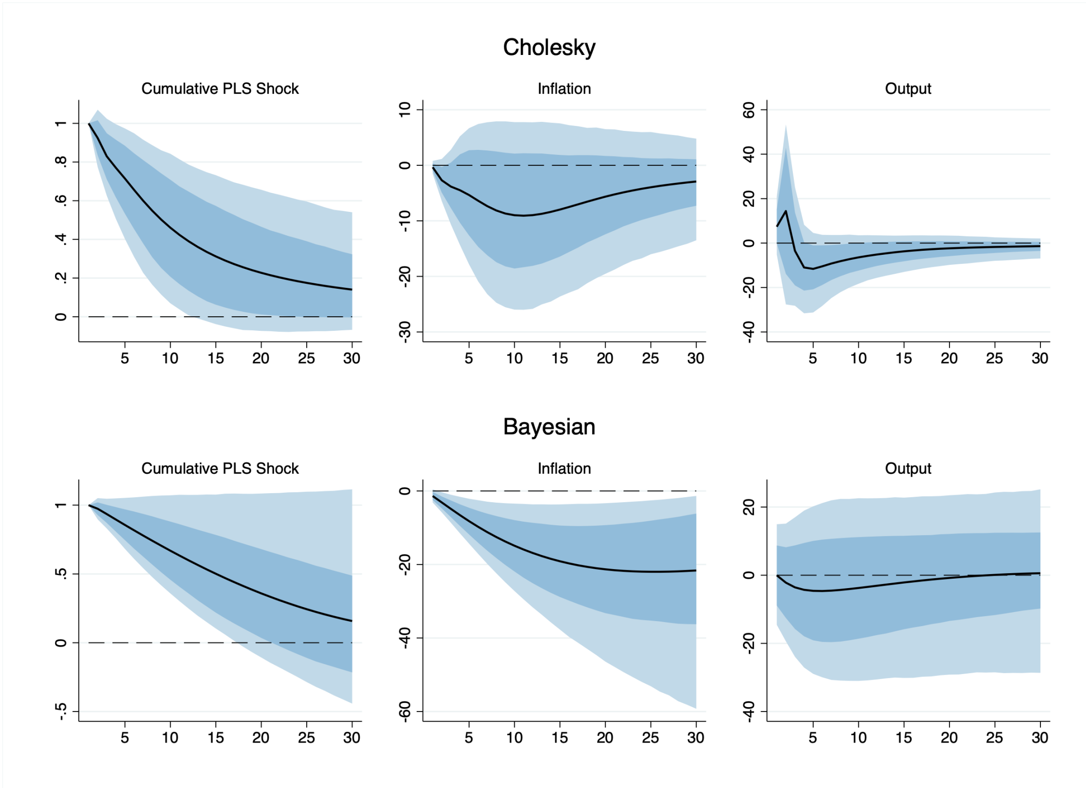
(g) Corporate Bonds (AAA, AA+, AA)



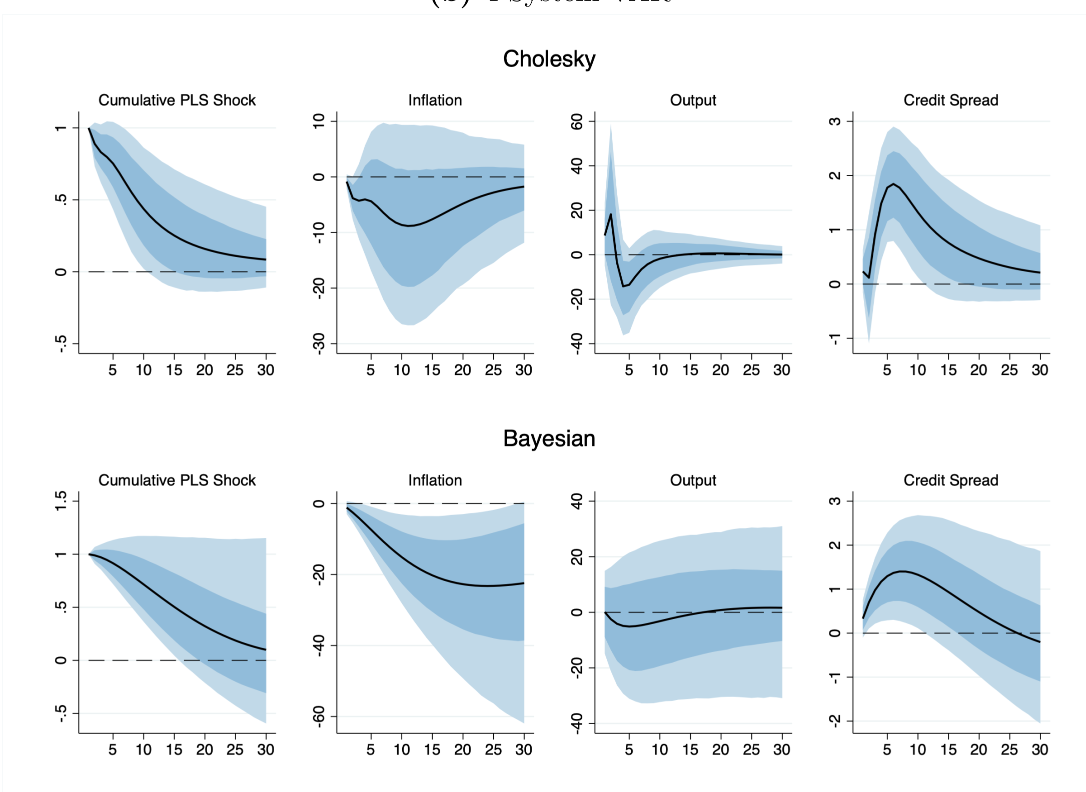
Note: The upper (lower) panel reports panel impulse response functions of yields of enterprise (corporate) bonds with AAA, AA+, and AA ratings to a 1 percentage point increase in the PLS shock series. Deep and shallow blue shaded areas are 68% and 90% confidence intervals produced by Newey-West standard errors.

Fig. 5. Impulse Responses - Structural VAR

(a) 3 System VAR



(b) 4 System VAR



Note: Impulse response of VAR with 3 and 4 variables are reported in Panel (a) and (b), respectively. Variables are ordered: cumulative PLS shock series, % growth of PPI, % growth of IVA, and credit spread. Deep and shallow blue shaded areas are 68% and 90% confidence intervals produced by bootstrapping 3000 times.

Table 5. Shock On Impact - IV Regression

(a) NCDs' Issue Rates & Yields (%)

	Primary Dealer's Issue Rate					Yields-to-Maturity			
	Urban(1Y)	1M	3M	6M	9M	AAA+(3M)	AAA+(6M)	AAA+(9M)	AAA+(1Y)
Primary(1Y)	1.1236*	2.2229**	1.9690***	1.2735**	0.8465*	0.4417*	0.4842	0.5693*	0.4011
	(0.5734)	(0.9066)	(0.6665)	(0.6103)	(0.4790)	(0.2521)	(0.2950)	(0.3011)	(0.2602)
Constant	-0.0059	-0.0248*	-0.0067	-0.0150	-0.0096	-0.0040	-0.0061	-0.0067	-0.0056
	(0.0094)	(0.0140)	(0.0116)	(0.0096)	(0.0082)	(0.0053)	(0.0049)	(0.0049)	(0.0040)
N	120	114	127	122	108	127	127	127	127
R^2	.	.	.	.	.	.	.	.	.

First stage regression: Robust F: 6.4920 p-value: 0.0120 R^2: 5.80% Adjusted R^2: 5.05%

(b) Inter-bank Market Rates (%)

	DR007	DR014	ShiborON	Shibor3M	FR007(1Y)	FR007(5Y)	Shibor3M(1Y)	Shibor3M(5Y)
Primary(1Y)	0.9663	1.2342	0.9087	0.2663**	0.3771*	0.3910**	0.5064**	0.4846**
	(0.7198)	(1.2408)	(0.6333)	(0.1103)	(0.2142)	(0.1924)	(0.2027)	(0.2143)
Constant	0.0029	0.0163	0.0063	-0.0027	-0.0116***	-0.0094***	-0.0154***	-0.0155***
	(0.0096)	(0.0186)	(0.0126)	(0.0019)	(0.0036)	(0.0033)	(0.0040)	(0.0041)
N	133	133	133	133	133	133	133	133
R^2	.	.	.	.	.	.	0.0304	0.1054

First stage regression: Robust F: 9.0375 p-value: 0.0032 R^2: 7.39% Adjusted R^2: 6.69%

(c) Bonds' Yields (%)

	3M	6M	9M	1Y	3Y	5Y	7Y	9Y	10Y	15Y	30Y
Treasury	0.4706*	0.2874	0.2863	0.4911**	0.5800**	0.6174**	0.4214**	0.4098**	0.4045**	0.4862**	0.4745**
	(0.2412)	(0.2179)	(0.1817)	(0.2066)	(0.2334)	(0.2516)	(0.1824)	(0.1791)	(0.1872)	(0.1932)	(0.2366)
Commercial(AAA)	0.9001***	1.2019***	0.9442***	0.7242***	0.5210***	0.3863**	0.3178**	0.3082**	0.2706*	0.2490	0.2947*
	(0.2847)	(0.3280)	(0.2275)	(0.1878)	(0.1613)	(0.1740)	(0.1515)	(0.1461)	(0.1608)	(0.1624)	(0.1646)
Enterprise(AAA)		0.6069***		0.5534***	0.4457**	0.4650**	0.3508**	0.2828**	0.3387***	0.2585***	0.2696**
		(0.2300)		(0.2038)	(0.2022)	(0.1825)	(0.1402)	(0.1210)	(0.1189)	(0.0939)	(0.1198)
Enterprise(AA+)		0.3166*		0.3864**	0.2979**	0.2489**	0.2098*	0.1307	0.1912*	0.2039**	0.1464
		(0.1743)		(0.1580)	(0.1381)	(0.1235)	(0.1146)	(0.1182)	(0.1110)	(0.0978)	(0.1088)
Corporate(AAA)		0.2895		0.3174**	0.2925*	0.3545**	0.3127**	0.3081**			
		(0.1780)		(0.1511)	(0.1570)	(0.1504)	(0.1348)	(0.1408)			
Corporate(AA+)		0.4460**		0.5314***	0.4243**	0.3637**	0.3693**	0.3088**			
		(0.2101)		(0.1975)	(0.1703)	(0.1564)	(0.1532)	(0.1450)			

First stage regression: Robust F: 9.0375 p-value: 0.0032 R^2: 7.39% Adjusted R^2: 6.69%

(d) Stock Market Returns $[t+4, t-1]$ (%)

	SSEC	SSEA	SSEB	CSI300	SZI	ChiNext	SZSE100R	SMEC
Primary(1Y)	-4.2121	-4.2096	-4.2876	-4.2931	-8.2060	-28.1295*	-8.8091	-9.0141
	(11.0174)	(11.0203)	(12.2615)	(10.8079)	(13.8062)	(15.5456)	(12.4298)	(14.9212)
Constant	-0.7156**	-0.7160**	-0.5502	-0.6967**	-0.9864***	-1.0137**	-0.7627**	-0.7806**
	(0.3219)	(0.3220)	(0.3817)	(0.3310)	(0.3759)	(0.4062)	(0.3545)	(0.3937)
N	133	133	133	133	133	133	133	133
adj. R^2	-0.01	-0.01	-0.01	-0.01	-0.00	0.02	-0.00	-0.00

First stage regression: Robust F: 9.2609 p-value: 0.0028 R^2: 7.58% Adjusted R^2: 6.88%

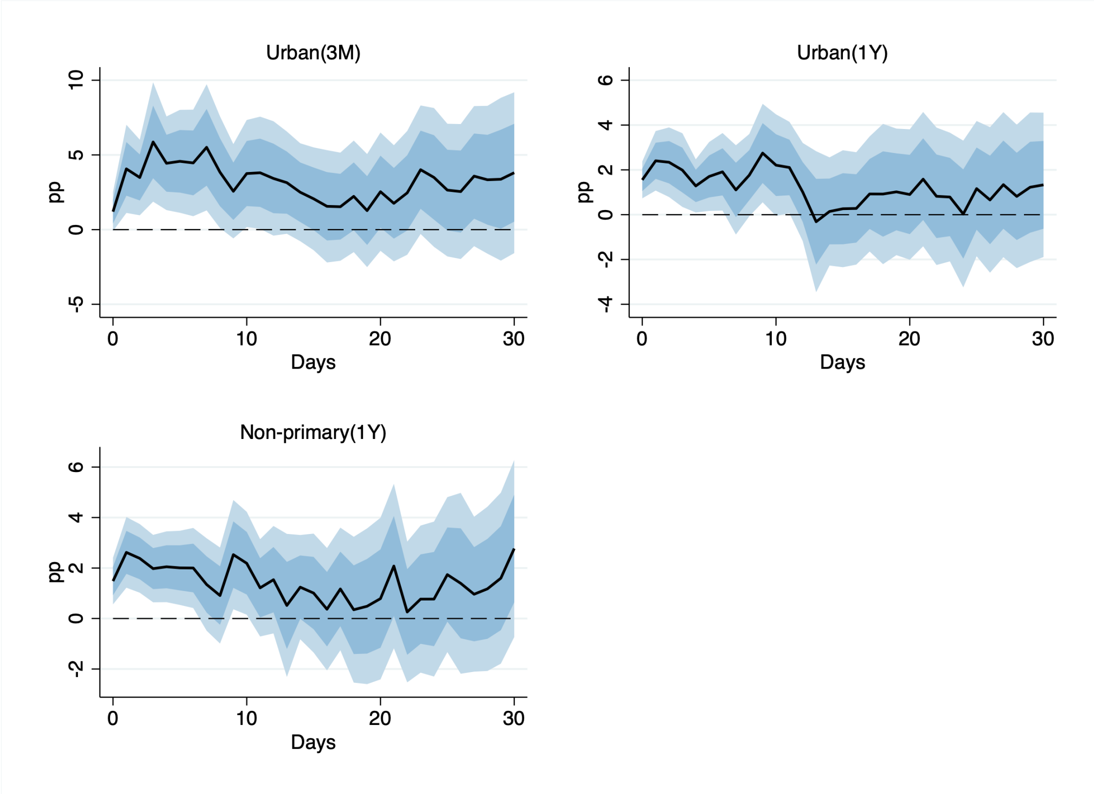
Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

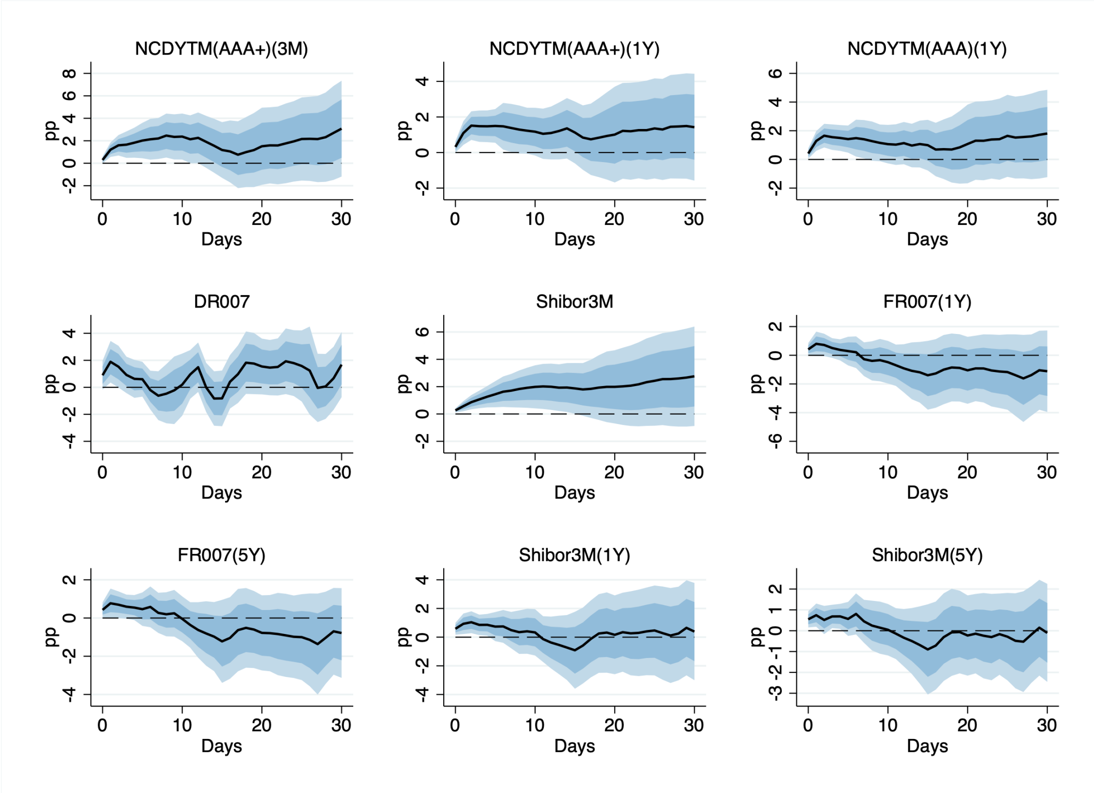
Note: This table presents the impact of 1 percentage point contractionary PLS shock on an array of financial products using instrumental variable regression where 1-yr primary dealers' NCD issuance rate is instrumented with PLS shock. This instrument NCD rate is henceforth denoted as "Primary(1Y)". In the context of stock market indexes, $\Delta y_{i,t} = y_{i,t+4} - y_{i,t-1}$ denotes the cumulative 5-day stock returns expressed in percentage terms.

Fig. 6. Impulse Responses - Local Projection (IV Regression)

(a) NCD Issuance Rates

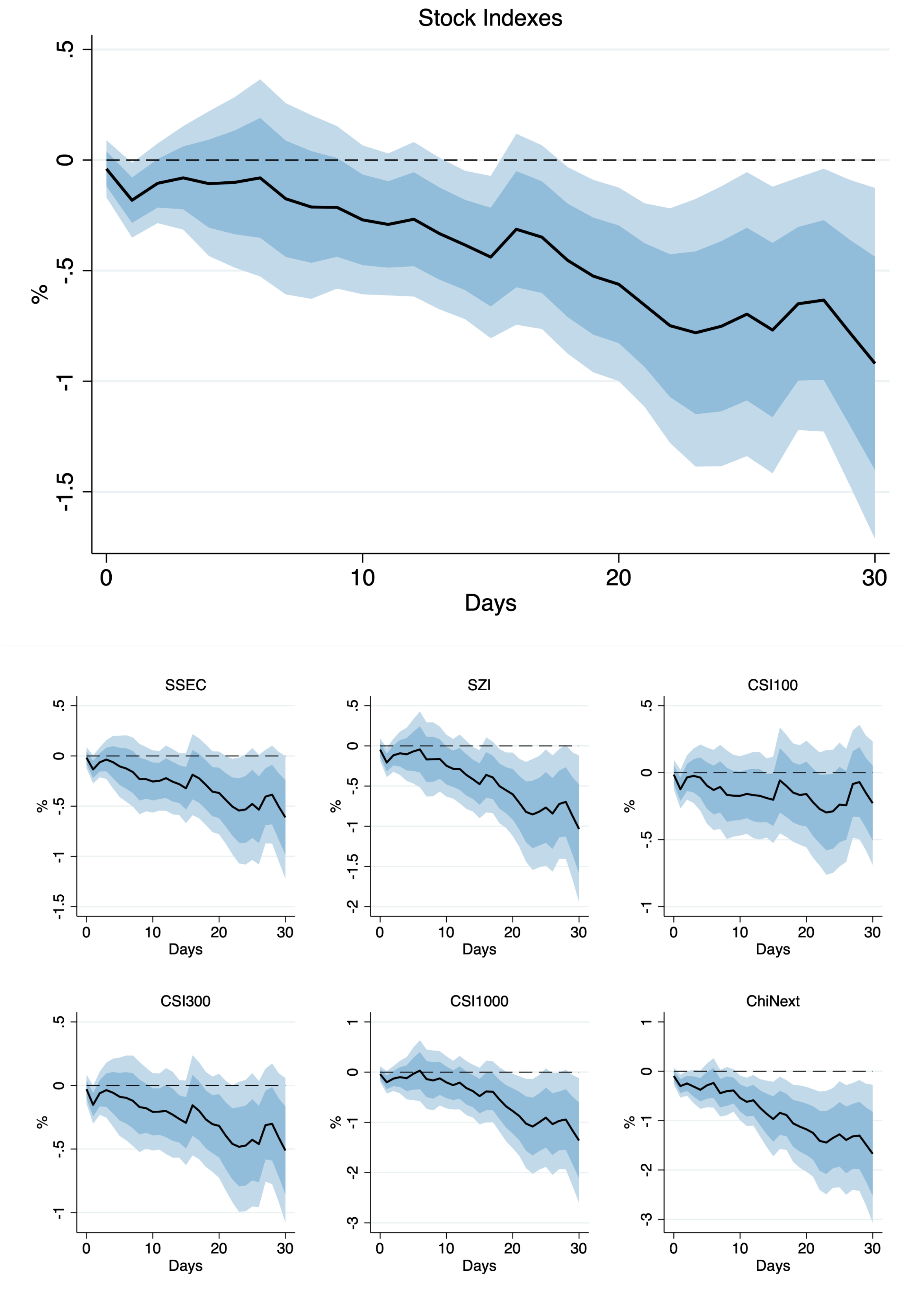


(b) Inter-bank Market



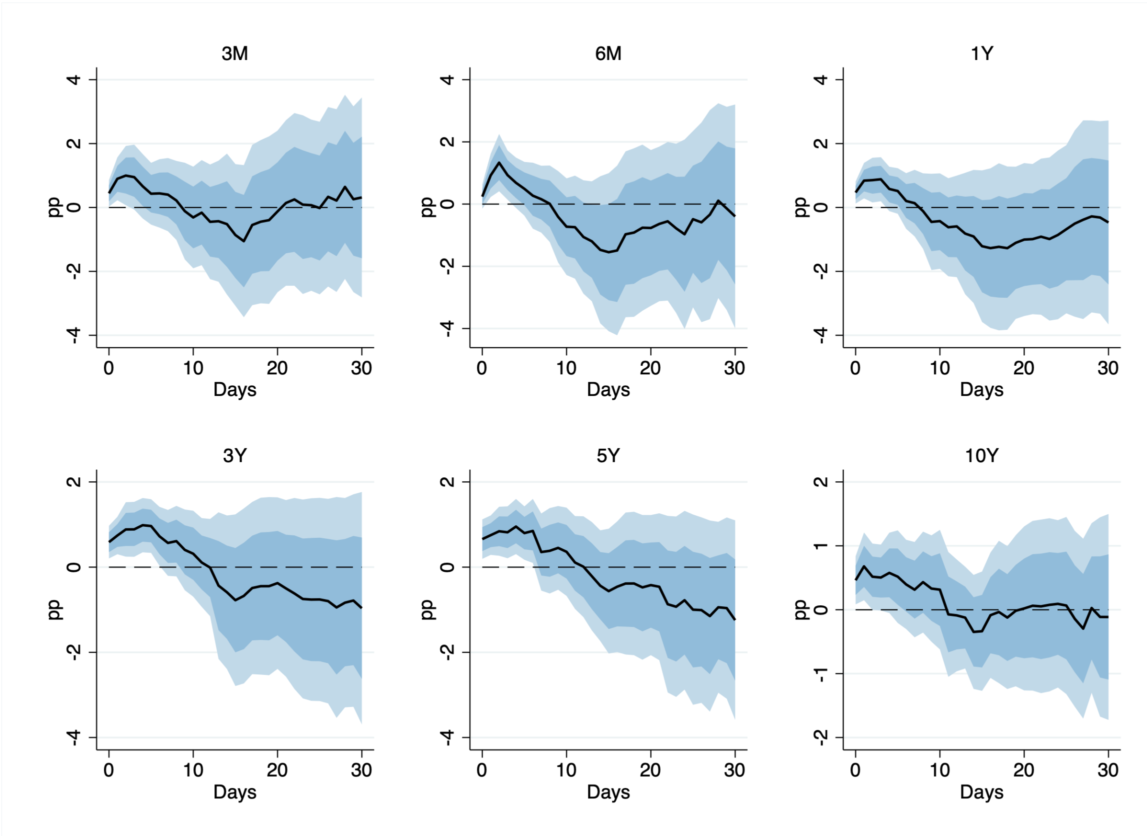
Note: Cumulative impulse response functions to a 1 percentage point increase in the PLS shock series. These functions are derived through IV regressions, with the Primary(1Y) variable being instrumented by the PLS shock. Deep and shallow blue-shaded areas are 68% and 90% confidence intervals computed using robust standard errors.

(c) Stock Market

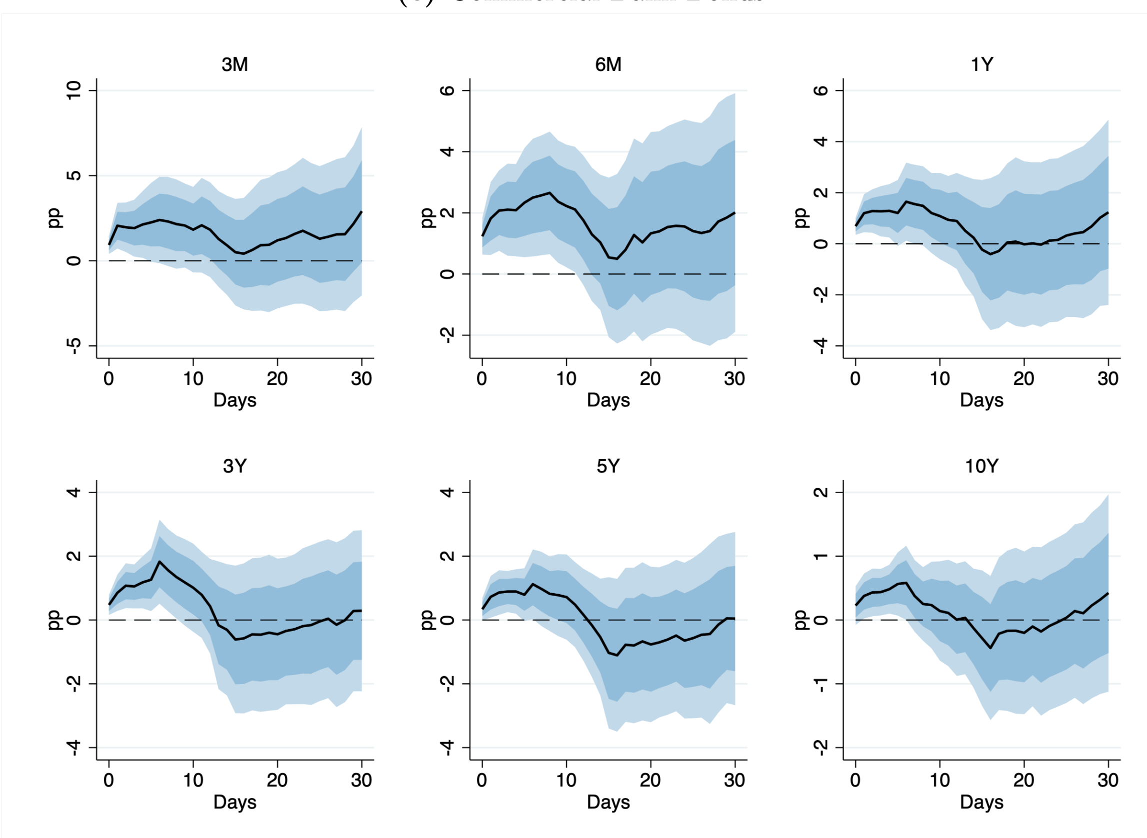


Note: The upper panel reports the panel impulse response function of prominent stock market indexes to a 1 percentage point increase in the PLS shock series. These functions are derived through IV regressions, with the Primary(1Y) variable being instrumented by the PLS shock. Deep and shallow blue-shaded areas are 68% and 90% confidence intervals generated by standard errors clustered at both month and index levels. The lower panel reports the impulse response function for individual stock market indexes, with confidence intervals calculated using robust standard errors.

(d) Treasuries

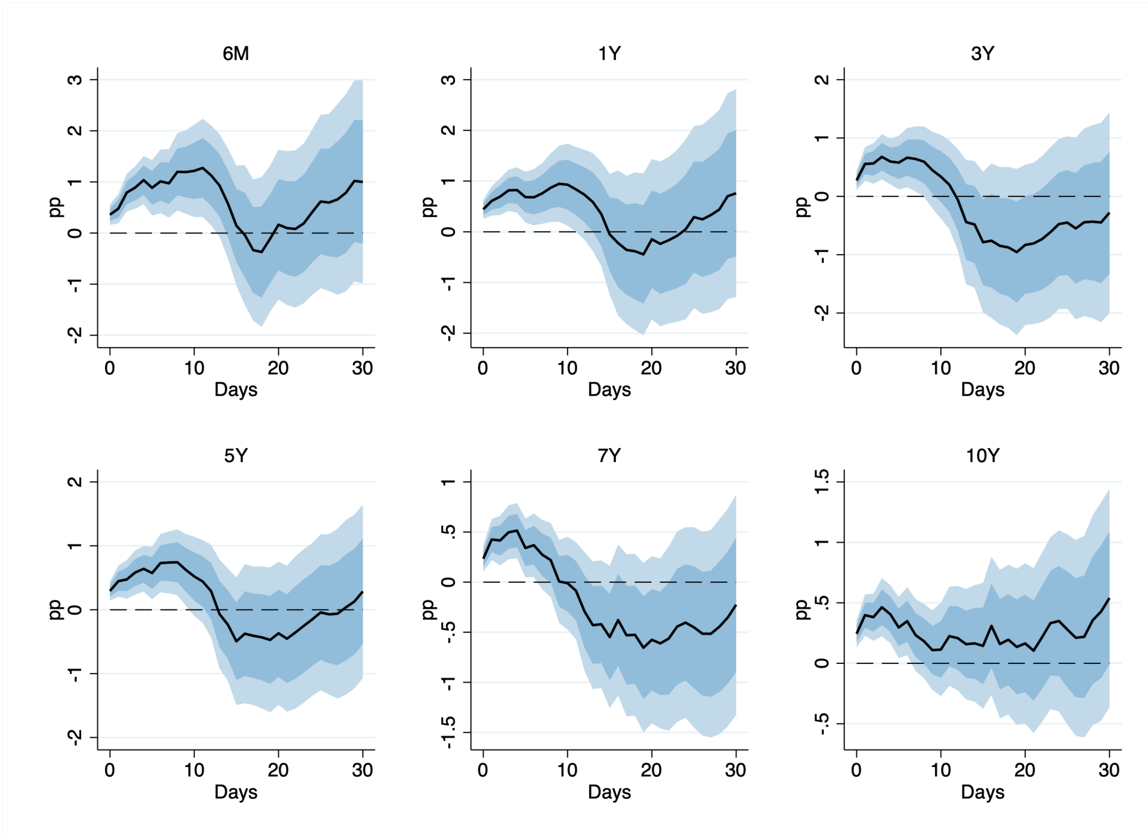


(e) Commercial Bank Bonds

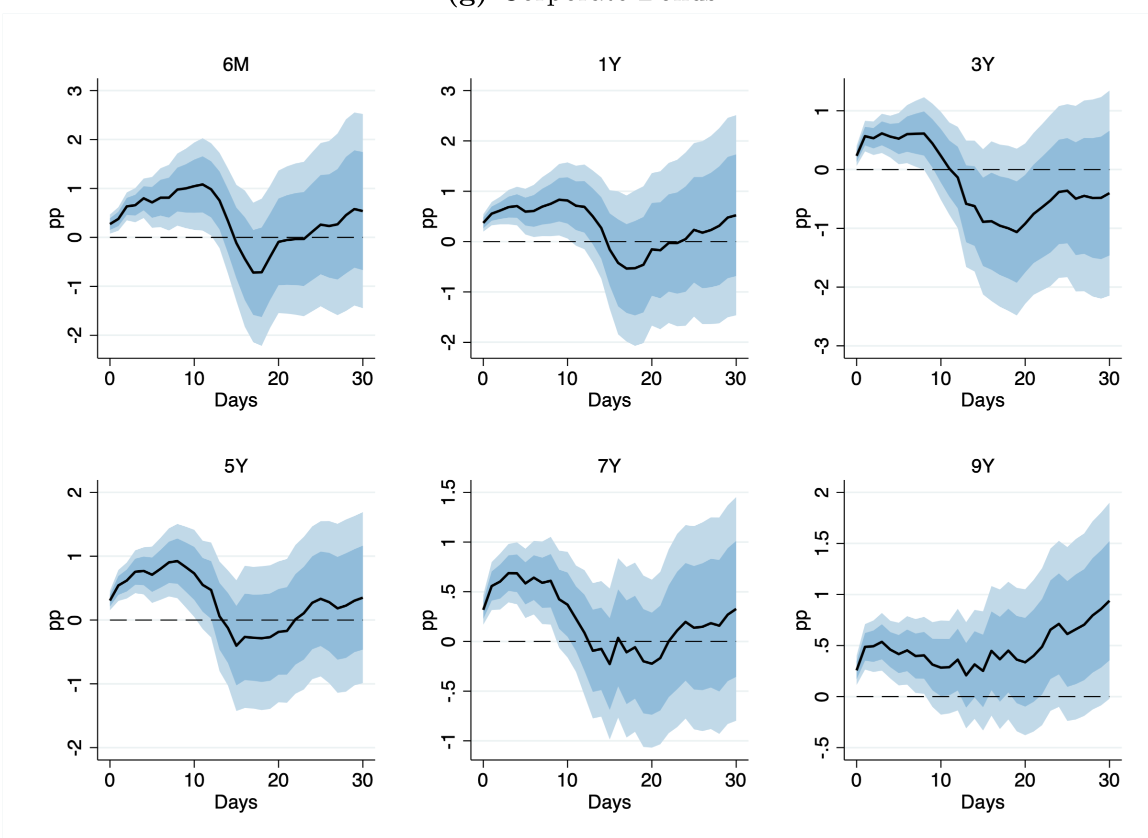


Note: The upper (lower) panel reports the impulse response functions of treasury yields (AAA-rated commercial bank bonds) to a 1 percentage point increase in the PLS shock series. These functions are derived through IV regressions, with the Primary(1Y) variable being instrumented by the PLS shock. Deep and shallow blue-shaded areas are 68% and 90% confidence intervals calculated using robust standard errors.

(f) Enterprise Bonds



(g) Corporate Bonds



Note: The upper (lower) panel reports panel impulse response functions of yields of enterprise (corporate) bonds with AAA, AA+, and AA ratings to a 1 basis points increase in the PLS shock series. These functions are derived through IV regressions, with the Primary(1Y) variable being instrumented by the PLS shock. Deep and shallow blue-shaded areas are 68% and 90% confidence intervals produced by robust standard errors.